NEW ZEALAND: GROWTH POTENTIAL OF THE BEEF AND DAIRY INDUSTRIES

FOREIGN AGRICULTURAL ECONOMIC REPORT NO. 97
ECONOMIC RESEARCH SERVICE
U.S. DEPARTMENT OF AGRICULTURE

ABSTRACT

New Zealand's beef and dairy production potentials through 1980 are evaluated. Trends in production, technology, Government policy, marketing, and the pricing system are studied in terms of their influence on future production. Livestock production alternatives are analyzed. Production response is estimated using multiple regression. Shortrun and longrun production elasticities are derived. Projections of production and export availabilities through 1980 are made under price assumptions and under physical and institutional constraints. Cattle numbers, dairy/beef numbers, and beef, veal, and milk production are projected to 1975 and 1980; primal (table beef) and manufacturing beef production estimates are made to 1980. Beef cattle numbers are projected to increase a minimum of 50 percent over the 1970 level, and dairy cattle numbers a maximum of 30 percent. New Zealand is expected to expand beef output rapidly while maintaining dairy and sheep production capacities for possible market breakthroughs.

Key words: Agriculture, Artificial breeding, Beef, Cattle, Cost and returns, Dairy, Farm characteristics, Land use, Livestock, Marketing, New Zealand, Pricing, Production response, Projections, Technology, Trade.

Washington, D.C. 20250

October 1974

FOREWORD

World demand for livestock products, particularly beef, is increasing with rising incomes. This study examines the prospects of continued expanded production in New Zealand, a major supplier of beef and veal to the United States, and the leading dairy exporter in the world. It evaluates the production potential of New Zealand's beef and dairy industries through 1980. Economic, technological, biological, and institutional factors are analyzed, and export possibilities are presented.

Most of New Zealand's dairy exports have traditionally gone to the United Kingdom, but these exports face increased price and market-entry problems now that the United Kingdom is a member of the European Community (EC). The United States is New Zealand's major market for beef and veal.

This study links with previous publications on grain and livestock production potential in Argentina, Australia, and Canada.

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EXPLANATORY NOTES

Except as noted, all data are in terms of New Zealand currency and English foot-pound weights and measures.

Monetary units: 1 New Zealand dollar = 1.12 U.S. dollars (April 1971)

" " = 1.35 " " (February 1973)

" " = 1.50 " " (September 1973)

Weights: 1 long ton = 2,240 pounds = 1.016 metric tons.

Meat production and utilization are in terms of carcass (bone-in) weight.

A diagonal slash (for example, 1969/70) refers to a financial, marketing, or production year. A dash refers to 2 or more years (for example, 1970-72).

Individual values may not add to totals because of rounding.

In the statistical estimation,

*** means significant at the 1-percent level;
** significant at the 5-percent level;
* significant at the 10-percent level.

The New Zealand Department of Agriculture became the Ministry of Agriculture and Fisheries at the end of 1972.

CONTENTS

SUMMARY

New Zealand can be expected to expand beef output through 1980 while maintaining dairy and sheep production capacities for possible market breakthroughs. Beef cattle numbers in 1980 are projected to be a minimum of 50 percent above the 1970 level, and dairy cattle numbers, a maximum of 30 percent higher.

Economic trends favored expansion of New Zealand beef production in the 1960's and moderated growth in dairy and sheep production. The number of dairy and sheep farms fell, while farms mainly in beef production or combining beef with dairy or sheep production increased.

The dairy industry is undergoing rapid structural change through amalgamation, geographic concentration of production, and technological progress. Productivity is increasing at a high rate. New milking systems are a key factor, allowing larger herds and labor savings. Major advances have been made in artificial insemination techniques.

The most important contribution to livestock expansion in the 1960's, however, was the general acceptance of higher stocking rates. This trend will continue, as feed supply increases and more efficient feeding techniques are extended. Supplementary feeding with concentrates would appear to be profitable only in limited circumstances.

"Bobby" calves--dairy farm calves that used to be slaughtered at an early age for veal--are now a significant source of calves for raising into beef cattle. Of an estimated 700,000 suitable calves, about half are now being raised for beef. The expansion of "dairy/beef" activities will continue as the number of Holstein-Friesian dairy cattle, a breed adaptable for both dairy and beef production, increases in proportion to the total dairy herd. Holstein-Friesians in 1973 comprised over 20 percent of the dairy herd, compared with 12 percent a decade earlier.

Various possibilities exist in New Zealand for integrating beef production into current dairy and sheep enterprises. Few farmers have achieved a stable beef system. Beef cattle raising is at the lower stages of the "learning curve," with major advances in production technology and marketing efficiency still to come. Use of artificial insemination for beef cattle was only beginning in the 1960's, so the major impact is expected to occur in the 1970's.

Beef production can equal or exceed the profitability of a number of sheep production activities. However, dairying is still more profitable than beef cattle raising in the major dairying areas, and the price of milk would have to fall considerably before beef would make much impact in replacing dairy production. Nevertheless, beef enterprises have been established as a hedge against adverse markets for dairy and sheep products, and as offering an easier way of life than dairying.

Projections of beef and dairy production are based on multiple-regression estimates of production response to price, subject to a number of price assumptions and physical and institutional constraints. The export market is taken as exogenous and perfectly elastic at the prices assumed. Sheep numbers are assumed to expand at less than 2 percent a year.

Projection set I assumes that the "beef price" will increase 4.2 percent annually during 1970-80 and the milk price, 1.5 percent. Beef cattle numbers would reach

8.2 million in 1980 and dairy/beef cattle 835,000. Total beef production would increase from 808 million pounds in 1970 to 1,642 million pounds in 1980, of which 452 million pounds would be "dairy/beef" from dairy/beef cattle. Beef and veal production combined would total 1,692 million pounds. The number of dairy cattle would increase to 4.5 million by 1980. Milk production would increase from 13.2 billion pounds in 1970 to 17.3 billion pounds in 1980.

Projection set II, considered less likely, assumes the beef price increases 7.5 percent a year during 1970-80 and the milk price, 4 percent. Beef cattle numbers reach 8.8 million; dairy/beef cattle, 893,000; and dairy cattle, 4.8 million. Total beef production would be 1,754 million pounds and milk production, 18.5 billion pounds. Projection set III, based on time trends, projects 7.4 million beef cattle, 4.7 million dairy cattle, 1,584 million pounds of beef, and 18.1 billion pounds of milk by 1980.

Maximum biological rates of beef herd expansion were calculated assuming different sets of biological variables. At assumed New Zealand conditions, the maximum growth rate was estimated to stabilize at about 7.6 percent a year by the late 1970's, allowing the beef herd to increase to nearly 10.8 million beef cattle.

Alternative combinations of beef cattle, dairy cattle, dairy/beef cattle, and sheep numbers were calculated assuming a fully utilized land carrying capacity of 130 million livestock or ewe equivalents. Allowing cattle numbers to increase according to the production response models with projection set I price assumptions would lead to a residual carrying capacity of 64.6 million ewe equivalents by 1979/80, sufficient for sheep numbers to increase at an average annual rate of 1.5 percent, up to 69.1 million sheep.

Estimates were made of primal (table beef) versus manufacturing beef production. Under projection set I, 1,206 million pounds or almost 75 percent of total beef production by 1980 is expected to be primal, compared with 40 percent in 1965/66. Even if all domestic consumption were primal, there would still be 882 million pounds of primal beef available for export. Total export availability would be 1,318 million pounds, of which two-thirds would be primal.

Export availabilities were calculated for each projection set as production minus domestic consumption. Beef and veal available for export in 1980 would range between 1,293 and 1,463 million pounds (carcass weight, bone-in). Actual exports, in product weight (boneless), would be about two-thirds of these figures. For milk and milk products, expressed as whole-milk equivalents, projection set I permits exports of 12.2 billion pounds, while sets II and III make possible 13.4 billion and 13.1 billion pounds, respectively.

NEW ZEALAND: GROWTH POTENTIAL OF THE BEEF AND DAIRY INDUSTRIES

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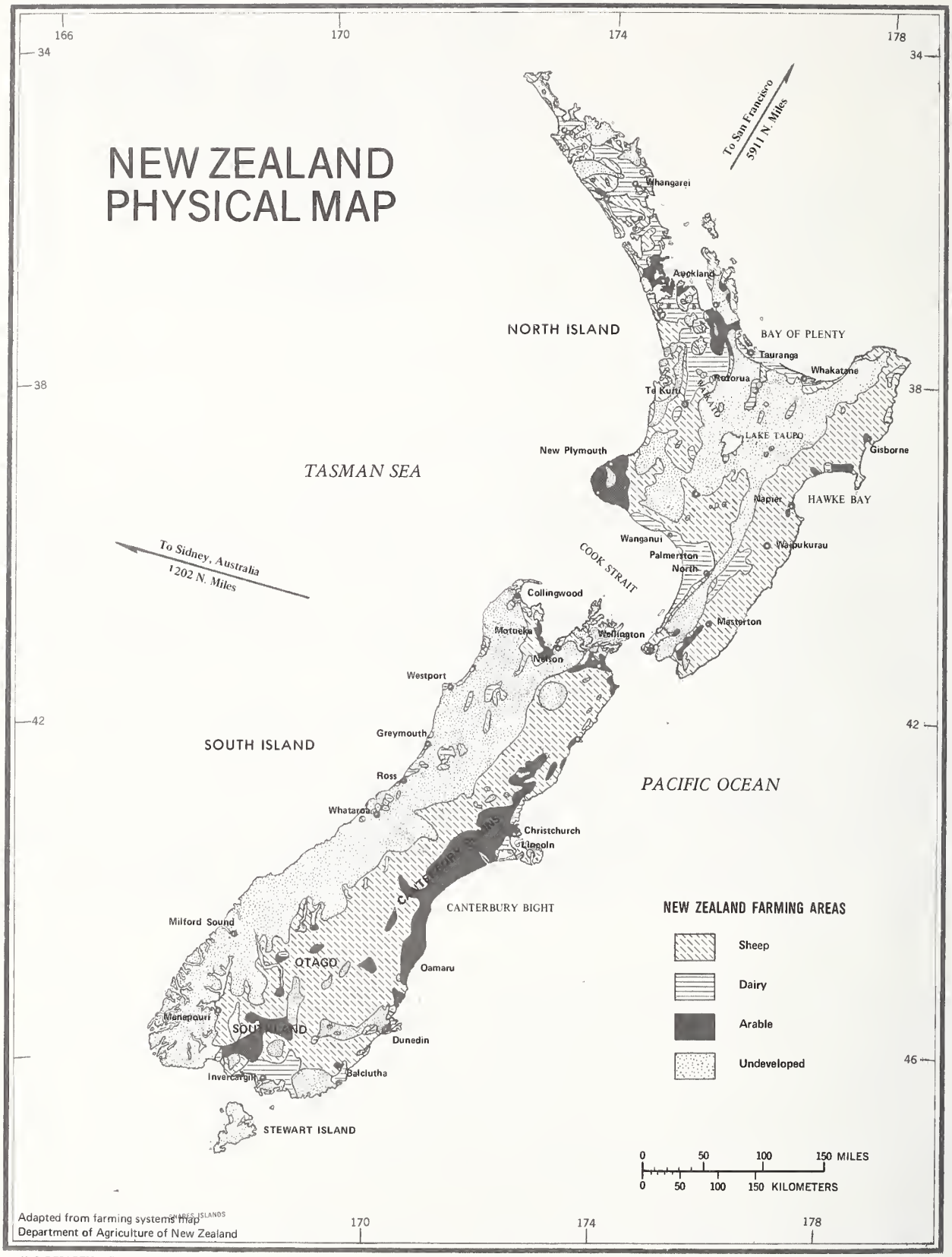
I. INTRODUCTION

This study evaluates the growth potential of New Zealand's beef and dairy production through 1980. Major factors influencing output in the 1960's are analyzed in terms of their possible influence on future beef and dairy production. The study identifies recent changes in the volume and pattern of livestock production; determines factors giving rise to shifts from dairying and sheep raising to beef production; measures production response to price; projects beef and dairy cattle numbers and volume of beef and dairy production to 1975 and 1980; estimates 1980 beef and dairy export availabilities and the 1980 level of primal beef (table beef) exports.

Rising incomes are greatly accelerating world demand for beef and to a much lesser extent, world demand for dairy products. New Zealand, heavily dependent on beef and dairy exports, has a vital interest in its potential for expanded output of these products, to share in particular in the rising world market for beef. Beef cattle numbers have increased rapidly in New Zealand, rising from 3 million head in 1960 to 5.7 million in 1973. Beef and veal production reached almost 1 billion pounds (carcass weight) in 1973. Exports, at 450 million pounds (product weight), were more than double the 1960 level. The United States is New Zealand's largest market for beef exports. Most of the exports consist of lean manufacturing beef (for hamburgers and sausages, for example). Production of primal beef (steaks and roasts) is increasing in importance, however.

New Zealand leads the world in dairy exports, supplying about one-fifth of the total. During 1960-73, dairy output advanced slowly to 13 billion pounds of milk, and the dairy herd grew from 3 million to 3.4 million head. Despite New Zealand's potential for competitive expansion of dairy production, dairy cattle numbers have actually fallen slightly since 1970, partly from unusually dry weather conditions, but mainly because of the uncertain long-term prospects for dairy export markets and the resulting reluctance to invest in dairying. New Zealand has had some success in market diversification, but its major butter and cheese outlet continues to be the United Kingdom, an economy lagging in growth and also, by its recent entry into the European Community (EC) posing price and marketing problems for New Zealand. New Zealand's dairy export receipts rose from about NZ$241 (US$270) million in 1969/70 to NZ$310 (US$347) million in 1972/73, mostly from price increases. Butter export volume was actually lower and cheese exports were only slightly higher than in 1969/70.



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NEG. ERS 1254-74 (7) ECONOMIC RESEARCH SERVICE

Figure 1

The U.S. beef herd is almost 20 times as large and its dairy herd about 5 times greater than New Zealand's. However, U.S. imports of beef and veal totaled almost 2 billion pounds in 1973, about double the 1960 level and equivalent to almost 10 percent of U.S. production; exports were less than 100 million pounds. As a major importer of beef, the United States is concerned with future availabilities and particularly the extent to which world supply and demand put pressures on U.S. import programs 1/ or the capacity of suppliers such as New Zealand to fulfill import demand at reasonable prices. One-fifth of U.S. beef imports come from New Zealand, the largest supplier after Australia. In 1973, U.S. imports of beef and veal from New Zealand totaled 291 million pounds valued at US$225 million. Dairy product imports amounted to US$57 million (259). 2/ U.S. imports of dairy products totaled 3.9 billion pounds (milk equivalent) in 1973, about 3.5 percent of U.S. production, compared with only 0.5 percent in 1960. U.S. exports were less than 1 percent of production in 1973.

II. THE LIVESTOCK INDUSTRY

This chapter first discusses New Zealand's physical setting. Sections follow on the beef industry, the dairy industry, and (because of its tie-up with beef) the sheep industry. Each industry is discussed in terms of farm operations, trends in livestock numbers, and volume of production.

Physical Setting

New Zealand comprises mainly two major islands--North Island and South Island, which have a combined length of almost 1,000 miles (fig. 1). The country is narrow and mountain ranges divide the two major islands into eastern and western sections. Nearly 85 percent of the land surface is 650 feet above sea level, but on both sides of the mountains are areas of flat land, mainly coastal strips and river valleys.

Climate and soils vary widely, but the farming areas, particularly in the north, have climatic factors exceptionally favorable to pasture growth--"a warm temperate summer and a coolish but definitely temperate winter-spring period, combined with high levels of solar radiation and, by world standards, a generously even spread of rain throughout the year (156)." Average rainfall is high, varying between 25 and 60 inches annually--a favorable range for plant growth. Mean temperatures vary between 50 and 60 degrees Fahrenheit at sea level. Over most of the country, there is bright sunshine for at least 2,000 hours a year 178. An investigation of the major pastoral production areas of the world confirms New Zealand's climatic comparative advantage (141).

The consequences of this physical setting for livestock production are that winters are mild enough in the North Island and parts of the South Island for animals to be grazed year round. Pasture growth in the North Island continues throughout the winter,

1/ P.L. 88-482, enacted August 1964, provides for a quota on imports of meat (except lamb). Quotas have never been imposed, having been periodically suspended by Executive Order since June 1972. See ch. VIII, p. 72.

2/ Underscored numbers in parentheses refer to literature citations at the end of this report.

and so reliance can be placed on pasture for feed. (Hay and silage provide most of the winter supplements; fodder is also used in the arable farming areas, which are almost entirely in the South Island.) The mild climate congenial to European cattle and sheep breeds makes it possible to take full advantage of the very considerable European background of animal breedings and selection.

Little of the land, however, is naturally very fertile. In many areas in the North Island, where the mountains are mainly volcanic, soil was marginal for farming until corrective fertilizers and trace elements were applied. Soil fertility in most of New Zealand has had to be built up by heavy applications of phosphate fertilizers. Legumes are used to improve the nitrogen content of the pasture and thus permit heavier stocking. Pastures are sown mainly with perennial rye grass and white clover and, once established, are seldom plowed but are regularly topdressed with fertilizer.

Land Use

New Zealand has a total land area of 66.4 million acres (about the same as Colorado). Land area is distributed as follows:

Item	Area
	Million acres
Land area:	
North Island	28.3
South Island	37.2
Smaller islands	.9
Total land area	66.4
Farmland:	
Improved grassland	20.4
Tussock & other native grassland	13.0
Grazing land	33.4
Field crops, orchards, & timber	2.6
Effective farmland	36.0
Idle farmland	7.0
Total farmland 1/	43.0
Farm ownership:	
Privately owned	22.0
Privately leased	1.4
Leased from the Government or other sources	19.6
Total farmland	43.0

1/ The rest of the total land area in New Zealand consists of cities, national parks, reserves and domains, state forests, and wasteland.

About half of New Zealand's total area is utilized in some form of livestock operation (table 1). Both the beef and dairy industries are concentrated in the North Island, where pasture growth is better because rainfall is higher and more evenly distributed. About 87 percent of the total number of cattle (80 percent of the beef cattle and 93 percent of the dairy cattle) are in the North Island. Sheep are about evenly distributed between the North and South Islands.

Table 1.--Land use in New Zealand, 1960/61 and 1969/70

Land use	1960/61	1969/70
	1,000 acres	
Area in crops, Jan. 31	1/ 1,219.9	1,088.8
Area in sown grasses (improved grassland for pasture)	18,823.1	20,415.4
	18,823.1	20,415.4
Fallow land	138.8	299.8
Orchards (commercial)	15.8	21.9
Market gardens and nurseries	12.9	20.7
Timber plantations	942.4	1,186.6
Total area cultivated	21,152.9	23,033.2
Private gardens, grounds, orchards		128.6
Natural grass and tussock land for grazing		13,000
Native bush	22,513.8	2,700
Unproductive land		4,200
Total unimproved land		2/ 19,913.8
Total farmland	43,666.7	43.075.6

1/ Includes 173,900 acres sown with grasses and clovers.
2/ Includes 13,800 acres not specified.

Source: (188, 1965/66; 191, 1969/70).

About 75 percent of the acreage principally in dairy farming (at least 75 percent of gross income derived from this source), and 29 percent principally in beef farming were in private ownership. The rest was leased from private owners or other lessors.

Farm Structure

Farming systems in New Zealand frequently combine a number of livestock enterprises (table 2). The 1970 Survey of Capital Expenditures listed 18,445 farm holdings engaged principally in dairy farming, 13,801 in sheep farming, and 2,500 in beef farming. 3/ There were, in addition, about 12,800 holdings of dairy-and-sheep, dairy-and-beef, and sheep-and-beef combinations with any one component activity accounting for at least 25 percent of gross income. Other combinations include field crops.

3/ The figures are underestimated by about 5 percent because of nonreporting (191, 1969/70).

Table 2.--Number of holdings by farm type, New Zealand, 1960, 1969 and 1970

Farm type	New Zealand			North Island			South Island		
	1960	1969	1970	1960	1969	1970	1960	1969	1970
	Number								
Principally dairy farming	26,415	20,520	18,445	23,888	18,724	16,780	2,527	1,796	1,667
Principally sheep farming	26,610	14,959	13,801	15,208	6,525	5,523	11,402	8,434	8,278
Principally beef farming	1,432	2,128	2,500	1,093	1,682	1,987	339	446	513
Dairy and sheep 1/	2,680	1,299	1,110	1,981	1,018	857	699	281	253
Dairy and beef 1/	--	713	804	--	646	710	--	67	94
Sheep and dairy 1/	1,575	572	520	841	395	367	734	177	153
Sheep and beef 1/	--	8,938	8,959	--	6,960	6,773	--	1,972	2,186
Beef and dairy 1/	--	229	253	--	198	212	--	31	41
Beef and sheep 1/	--	994	1,144	--	820	959	--	174	185
Mixed livestock	--	1,578	1,616	--	1,279	1,304	--	299	312
Sheep and cropping 2/	--	3,622	3,351	--	348	325	--	3,274	3,026
Principally cropping	--	1,627	1,555	--	515	495	--	1,112	1,060
General mixed farming	1,564	2,215	1,769	689	853	668	875	1,362	1,101
Market farms and gardens	--	709	674	--	477	427	--	232	247
Other	16,652	2,725	2,793	8,537	1,423	1,480	8,115	1,302	1,313
Total	76,928	62,822	59,294	52,237	41,863	38,867	24,691	20,959	20,427

1/ With the first-named component earning 50-75 percent of gross revenue The number of holdings for 1969 and 1970 are based on data from Capital Expenditure Surveys which, because of nonreturns, underestimates total holdings by about 5 percent. (The Survey was started in 1965/66).

Source: (187, 1971; 188, 1968/69; 191, 1969/70).

Of the 2,500 principally beef farms in 1970, about 2,000 were in the North Island, mostly in Northland, Central Auckland-South Auckland, and Bay-of-Plenty (these and other statistical areas in New Zealand are shown in fig. 2). More than half were in holdings of less than 150 acres, and there were only a few farms bigger than 400 acres.

About 16,800 of the 18,445 farms engaged principally in dairying were in the North Island, with most farms in the South-Auckland, Bay-of-Plenty area and in Taranaki. About 60 percent of these farms were in holdings of 75 to 200 acres, and about 90 percent were 50 to 400 acres.

The density of sheep holdings remains highest in the Southland-Otago-Canterbury area and in Wellington. Of the 13,801 principally sheep farms in 1970, about 8,300 were in the South Island and 5,500 in the North Island. Acreage per sheep farm was considerably greater than for dairy or beef farms in 1970, with the most common farm size being 250 to 399 acres and about two-thirds of the farms ranging from 200 to 2,000 acres.

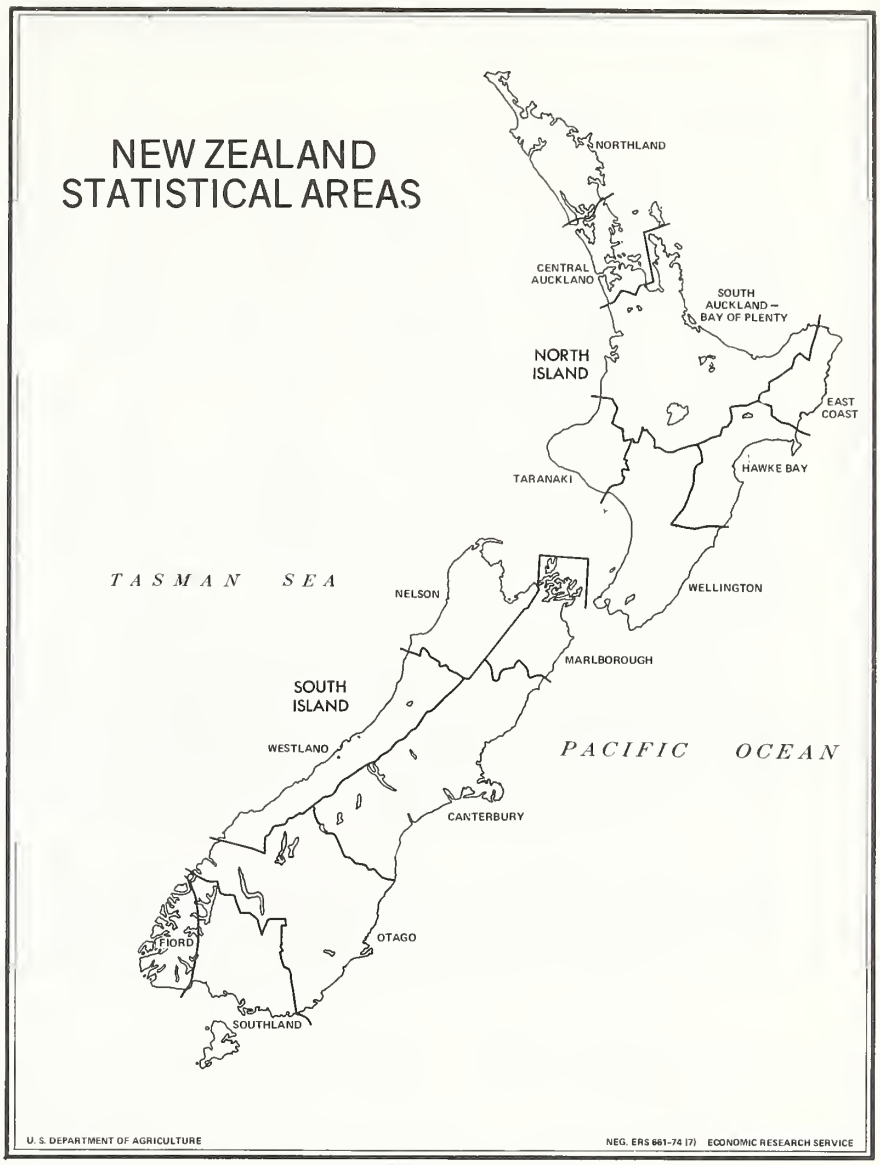

Figure 2

As table 2 indicates, the total number of farm holdings in New Zealand declined from nearly 77,000 in 1960 to about 59,000 in 1970. But enterprises engaged principally in beef farming increased 75 percent. Also, beef-and-dairy farms and beef-and-sheep farms (in each case, beef represents at least 25 percent of gross income) increased in numbers.

The overall decline in farm holdings reflected a 30-percent drop in farms engaged primarily in dairying and a 48-percent decline in those engaged principally in sheep raising. Dairy and sheep farms became more diversified or were amalgamated into larger units. The decrease in number of dairy farms also reflected withdrawals from dairying in mixed farming and marginal lands and greater opportunities taken of potential size economies in milk production (17).

Beef Cattle Raising

As late as 1969, only a few all-beef farms existed in New Zealand (144). About 90 percent of the beef cattle are run on hill-country sheep farms and finished on lamb-fattening farms (114). Calves are either sold as weaners at 4 to 8 months of age or carried for another 6 to 12 months before being sold for fattening on lamb-fattening farms. Some lamb-fattening farms, however, independently breed beef cattle. To make better use of pastures, sheep farmers often purchase store (feeder) cattle, and the cattle are fattened on the sheep farm or later sold to fattening farms. Calves or cattle sold for fattening usually go on to flat or easy, rolling country with high-quality grassland, and then they are sold at about 18 to 20 months of age.

Some cattle are kept in hill country for pasture control until they are 3 years old or older, but hill-country development and recent price margins in favor of young cattle (leaner carcasses) are inducing earlier release of cattle. Hill-country development has also made it possible for some farms to fatten at least part of their stock to be sold as slaughter steers.

Until fairly recently, cattle were used almost exclusively in a complementary relationship with sheep as "cultivating implements" to control pasture growth in the spring and early summer and, on rougher country, to crush fern, scrub, and second growth. 4/ Interest in beef production on its own merits did not occur until the mid-1950's, after bulk purchase agreements with the United Kingdom were terminated and New Zealand was able to take advantage of the rise in world beef prices associated with cattle buildup in the United States and increased U.S. import demand. 5/

Part of New Zealand's beef supply comes from dairy farms. The dairy industry has traditionally supplied cull cows, cull bulls, and bobby calves (calves surplus to the milking herd) for beef and veal. Only since the 1960's, however, have dairy farms bred and raised cattle directly for beef (see Dairy Industry section on "dairy/beef").

Beef Cattle Numbers

The total number of cattle in New Zealand increased steadily from 6.0 million head in 1960 to 8.8 million in 1970 (table 3 and app. table 1). Beef cattle accounted for most of the growth, increasing 67 percent, from 3.0 million to 5.0 million head.

4/ It was claimed for cattle that "they crush certain weeds and eat others on which sheep have little or no effect; they spread grass and clover seeds via their feces more effectively than sheep; that by the nature of their grazing habit they control surplus seasonal growth in pasture, keeping it short in a form suitable for sheep utilization." These claims suggest that increasing the cattle stocking rate (up to a point) "does not depress the potential stocking capacity with sheep, and may initially even increase it." In addition the low labor unit requirement for cattle allows the cattle to be carried "to absorb grazing potential when labor supply is a limiting factor as far as sheep are concerned. . .(thus) increasing cattle numbers may not decrease the numbers of sheep which can be handled by an existing labor force" (144).

5/ These agreements were initiated in World War II to help assure food supplies to the United Kingdom. See ch. 8.

Table 3.--Livestock numbers and ewe equivalents, New Zealand, 1959/60-1972/73

Year 1/	Ewe equivalents 2/	Total cattle	Beef cattle	Beef breeding cows	Dairy cattle	Dairy cows in milk	Sheep
	Million	1,000 head					
1959/60. .	74.6	5,973.4	2,696.7	917.8	3,003.7	1,931.1	46,876.2
1960/61. .	3/77.0	5,991.9	3,019.2	968.4	2,972.8	1,886.7	47,133.6
1961/62. .	3/79.1	6,445.8	3,334.3	1,047.4	3,111.5	1,928.8	48,462.3
1962/63. .	80.1	6,597.9	3,462.4	1,113.2	3,135.6	1,868.1	48,988.0
1963/64. .	81.3	6,691.0	3,557.9	1,113.7	3,133.1	1,997.3	50,190.3
1964/65. .	82.8	6,696.2	3,567.8	1,141.2	3,128.4	2,010.9	51,291.9
1965/66. .	87.0	6,801.3	3,627.6	1,120.0	3,173.8	2,032.2	53,747.8
1966/67. .	92.7	7,217.7	3,856.1	1,214.2	3,301.6	2,087.9	57,343.3
1967/68. .	97.6	7,746.9	4,241.2	1,337.9	3,505.7	2,131.4	60,030.0
1968/69. .	99.9	8,247.2	4,549.1	1,448.0	3,698.0	2,232.5	60,473.6
1969/70. .	3/100.5	8,604.9	4,811.8	1,486.3	3,793.1	2,304.3	59,937.4
1970/71. .	104.4	8,777.3	5,048.0	1,518.6	3,729.3	2,320.6	60,276.0
1971/72. .	n.a.	8,818.0	5,279.0	1,557.0	3,539.0	2,239.0	58,912.0
1972/73. .	n.a.	8,999.0	5,574.0	1,919.0	3,425.0	2,218.0	60,100.0

n.a. means not available.

1/ Cattle numbers are for the season ending January 31 of initial year. Sheep numbers are for the season ending June 30 of initial year. Ewe equivalents are comprised of sheep in initial year and cattle in terminal year.

2/ Livestock numbers converted into homogeneous units on the basis of feed requirements. See Appendix C.

3/ Estimated by author.

Sources: (194, 1970/71, 1971/72; 188, 1968/69; 191, 1969/70).

The increase in beef cattle was more rapid toward the end of the decade: 39 percent in 1965-70, compared with 20 percent in 1960-65. The trend annual growth rate for beef cattle was 4.9 percent, compared with 3.8 percent for total cattle. 6/ By 1972, the number of beef cattle had reached almost 5.6 million head--over 10 percent more than in 1970.

Evidence of beef herd buildup is shown by slaughter figures. Each year about one-third of all cattle are slaughtered, but while cattle slaughterings increased 92 percent during 1960-70, there was an increase of only 6 percent in slaughter of calves (194, 1970/71).

Location

About four-fifths of New Zealand's beef cattle are located in the North Island, particularly on the east coast hill properties extending from Wellington to Gisborne. 7/ The South Island has lagged in beef production mainly because of less suitable climate: colder and longer winters and extended dry summers with periodic droughts in some major areas. Also, topdressing and oversowing to develop the hill country in the South Island has not been as extensive as in the North Island (267). By 1959, however, expansion of beef production was being advocated for the South Island: "With its cropping for stock-feeding and its larger area of breeding and fattening country, it could in time produce beef exports comparable in quantity and quality with that produced in the North Island (7)."

During 1960-70, beef cattle numbers in the South Island more than doubled, increasing from 470,000 to over 1 million head. Expansion was most rapid in the Otago, Canterbury, and Southland areas. In 1970, the South Island accounted for 20 percent of all beef cattle in New Zealand, compared with 15.5 percent in 1960. In the development of the South Island for beef production, increased reliance is placed on supplementary feed (hay and especially silage) for emergency supply and as regular winter and summer feed.

In the North Island, 1960-70 growth in the beef herd was most rapid in Northland, where numbers more than doubled. South Auckland-Bay of Plenty showed the greatest increase in absolute numbers--over 78,000 head. Most beef cattle are still located in South Auckland-Bay of Plenty and in the Hawke Bay and Wellington areas.

Ratios of beef cattle to sheep vary among the different areas. In Northland, the ratio of cattle to sheep is 1 to 4; in Wellington, 1 to 11; and in the South Island, on the average, 1 to 27. A higher percentage of cattle is carried on the more extensive properties because of labor constraints and the need for roughage control. In general, the proportion of beef cattle to sheep is higher in rougher and drier country. During 1960-70, the proportion of beef cattle to sheep rose from 1:16 to 1:12 for all of New Zealand, and from 1:45 to 1:20 in the South Island (188).

The beef cattle fattening process is usually restricted to the more fertile and improved pastures, while the breeding of store animals is relatively flexible with respect to pasture type. As a result, a pattern of beef cattle raising similar to that of sheep farming has developed. Hill-country store beef stock are transferred to the

6/ All time trends were computed by ordinary least squares from semilog linear regression equations.

7/ Beef cattle numbers are locationally classified by Statistical Areas, but cost and returns (income) data on beef are given in Sheep Surveys which use a locational classification based on class of land for sheepfarming, divided into North and South Islands (app.F)

fattening areas in the same way store sheep stock are drafted annually--for example, from northern areas centered on Gisborne to the South Auckland fattening areas (144).

Dairy Industry

New Zealand's dairy industry includes several subindustries whose activities occasionally overlap, but which can be classified as follows.

Dairy Factory Suppliers

These are the farms that supply most of the milk produced in New Zealand. The milk is processed by dairy manufacturing industries, which turn out butter, cheese, and byproducts of butter manufacture, such as skim milk powder, casein, and buttermilk powder.

Dairy factory suppliers produce practically all pork in New Zealand. Pig production has declined considerably, however, as prices for skim milk have risen and as tanker collection of milk has become extensively adopted. Tanker collection has meant the demise of home separation of cream from milk and the loss of an on-farm supply of skim milk for pigs.

Factory-supply dairy farms are the focal group in the subsequent analysis of dairy production patterns and trends. The more specialized subindustries are first discussed briefly.

Town Milk Suppliers

About 10 percent of New Zealand's total milk production comes from town-supply farmers, who provide whole milk for local consumption. During the 1960's, production rose steadily in response to population growth, increasing from 100.3 million gallons (1.03 billion pounds) in 1959/60 to 139.4 million gallons (1.44 billion pounds) in 1969/70. Production costs of town suppliers are greater than for factory-supply farmers because milking cows are required yearround and because more labor at higher wage rates is needed (90). In addition, milk output per cow and per acre is less on town-supply farms (because production is maintained even in the less favorable periods of the year). The farms are usually more lightly stocked than factory-supply farms to permit more hay and silage to be conserved for cows milked in winter (176).

Bobby Calf Industry

"Bobbies" are calves of less than 100 pounds (live weight) to be slaughtered for meat purposes. They are the unwanted byproducts of the dairy industry, being surpluses to milking herd requirements (102). The meat from bobby calves is "boneless bobby veal," almost all of which is exported. Other veal comes from older calves (up to 10 months of age); most of this veal is consumed in New Zealand.

The bobby calf industry consists of about 130 marketing pools and federations of pools to coordinate the collection of calves from farms. This system has eliminated the haphazard and inefficient handling of calves prevalent in the 1930's.

An increasing number of calves are being raised under specialized conditions for beef (see below). Bobby veal slaughter for export fell from an average of 298,000 carcasses in 1959-61 to 273,000 carcasses in 1968-70 (194, 1969/70).

Dairy/beef Industry

In the traditional dairy industry structure, surplus milk calves (bobby calves) are simply slaughtered, yielding only small amounts of veal. Recently, crossbred calves (dairy and beef cattle) or suitable dairy breed calves (for example, Holstein-Friesian calves) have been reared to a more profitable stage to produce sizable beef carcasses. These beef production activities of dairy farms are the basis of the dairy/beef industry.

"Dairy/beef"--the beef from dairy/beef enterprises--is distinguished, in this report, from the all-inclusive term "dairy beef," which is "meat from cattle which are of dairy breeding or are the progeny of crossing dairy cows with bulls of any of the beef breeds (11)." The more general term "dairy beef" used to be almost exclusively the inferior product from aged and wornout dairy cows and bulls culled from the herd, but now an increasing proportion is made up of "dairy/beef" derived from dairy-bred steers and heifers raised purely for beef purposes--the dairy/beef enterprise.

Dairy/beef production, a major development in the pattern of New Zealand beef supply, did not catch hold and become a growing practice until the 1960's. This delay was largely a matter of economics. Although beef exporters were maintaining that they could profitably sell greater quantities of beef, beef production in New Zealand was returning a relatively lower profit per acre than dairying, lamb-and-wool, or cropping (11). However, in the 1960's the combination of higher prices for beef, uncertainty in dairy marketing, and a decline in wool prices sufficiently altered profitability prospects to change established production patterns. Other factors were: (1) availability of beef full semen through the Dairy Board's artificial insemination service, which facilitated production of beef-type animals from dairy cows (25, 51); (2) the Government's Beef Diversion Incentive Scheme (effective from 1969 to 1971); and (3) recognition of the Holstein-Friesian breed of cattle as an efficient producer of either beef or milk. The rapid adoption of the Holstein-Friesian is one of the significant developments of the decade. (These factors are discussed further in Chs. III and IV.)

There are several beef production activities in which dairy farms might engage. This is shown in figure 3, a schematic represenation of enterprises within the dairy/beef industry. The dairy farms, for example, might rear bobby calves to 4-month old weaners for sale to sheep farms; or the weaners might be carried through the winter and then sold as store cattle in the spring, or carried through to fattening and slaughter at 16 to 22 months of age.

In the 1969/70 season, 250,000 calves were reared for beef on dairy farms, of which 162,000 were wintered on dairy farms in 1970. In the 1970/71 season, the estimate is for 350,000 calves reared and 261,000 wintered on dairy farms.

The supply of dairy calves suitable for fattening for beef production is still substantially larger than the number retained for this purpose. Of the 1.3 million calves slaughtered in 1969/70 (mostly for bobby veal), more than 500,000 could have been reared for beef (174; 10; app. A).

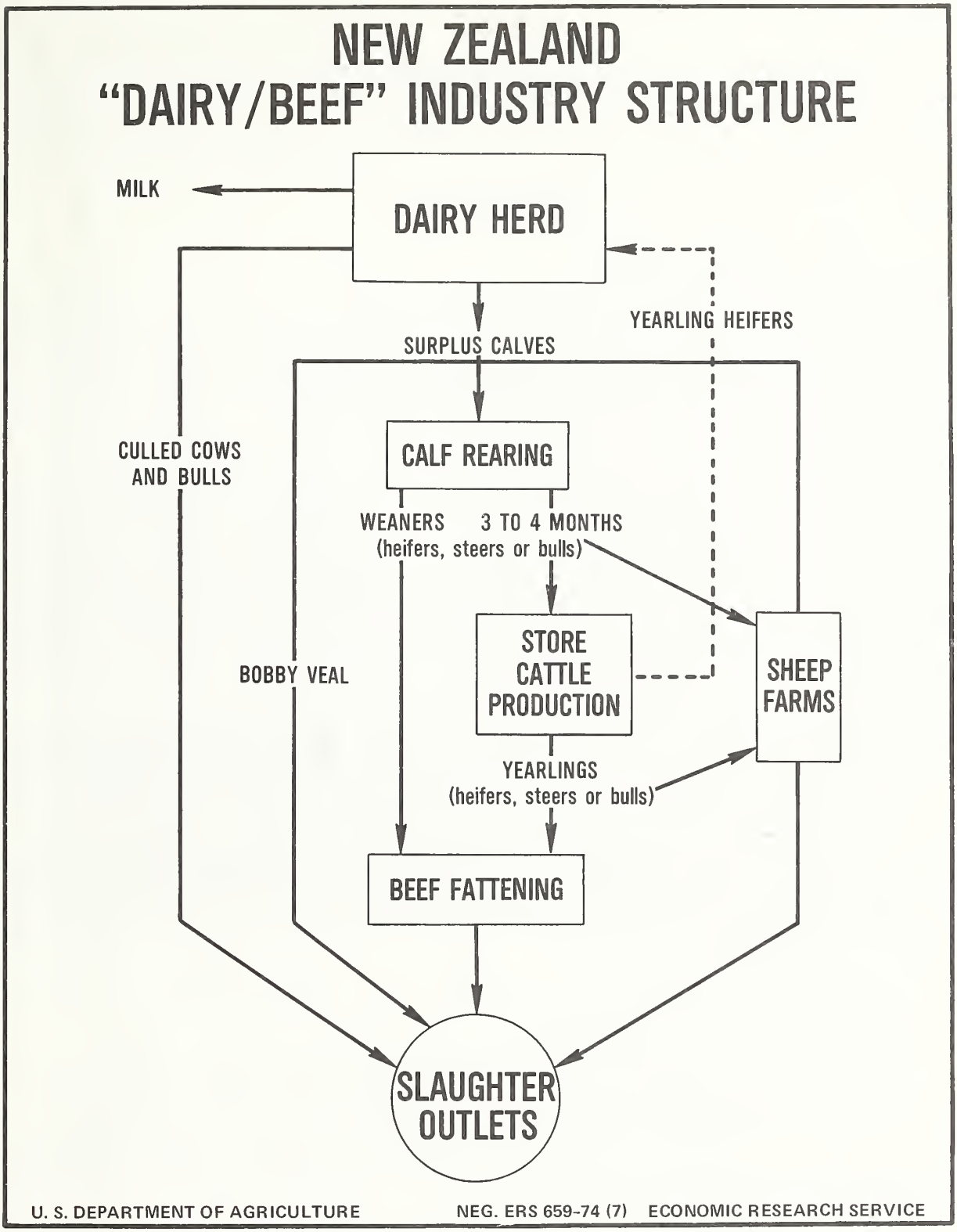
NEW ZEALAND
"DAIRY/BEEF" INDUSTRY STRUCTURE
MILK
DAIRY HERD
YEARLING HEIFERS
SURPLUS CALVES
CULLED COWS AND BULLS
CALF REARING
WEANERS
3 TO 4 MONTHS (heifers, steers or bulls)
BOBBY VEAL
STORE CATTLE PRODUCTION
SHEEP FARMS
YEARLINGS (heifers, steers or bulls)
BEEF FATTENING
SLAUGHTER OUTLETS
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 659-74 (7) ECONOMIC RESEARCH SERVICE

Figure 3

Dairy Cattle Numbers

The number of dairy cattle in New Zealand increased from 3.0 million to 3.7 million head during 1960-70, a trend annual growth rate of 2.5 percent (table 3 and app. table 2). 8/ Total dairy cattle numbers reached a record 3.8 million in 1969 but dropped to 3.5 million in the 1971 drought year. The number of milk cows fell 2 percent in 1972, but somewhat recovered in 1973 because of improved prices for dairy products and a marked renewal in the industry (174, 1972/73).

Location

The principal dairying areas are the Waikato (South Auckland) and Taranaki, where average rainfall is between 40 and 50 inches a year. Auckland, the Bay of Plenty, and Wellington are other areas with high summer rainfall and short winters--conditions conducive to yearround pasture growth. In the South Island, most of the dairy farmers are town-milk suppliers located near cities.

Dairy cattle in the North Island increased from 91 percent of all dairy cattle in New Zealand in 1960 to 93 percent in 1970. Of the total increase of 820,300 head between 1960 and 1969, only 10,000 were accounted for by the South Island, and between 1969 and 1970, disinvestment in dairy farming was relatively greater in the South Island. Most of the 1960-70 increase in dairy cattle took place in South Auckland-Bay of Plenty, which even in 1960 already had the highest number of dairy cattle. Cattle numbers increased 35 percent in the area, and in Taranaki, which has the second highest number of dairy cattle, there was an increase of 40 percent. On the east coast, dairy cattle numbers decreased 37 percent (188).

The increased concentration of dairy cattle in the North Island, contrasting with the static situation in the South Island and decline in the eastern districts, stems from a number of reasons. The climatic advantages of areas where winters are short, summer droughts infrequent, rainfall abundant, and grass growth relatively sustained and predictable, became more apparent as stocking rates were increased to offset declining profit margins. Demand for liquid milk increased faster in the more rapidly growing northern urban areas. New farms were established on bush and scrub areas in the Central Plateau (Auckland) and in Northland. In the North Island, there was widespread adoption of herringbone-design milking systems, which allow herd size to increase without increasing labor requirements for milking (29).

Sheep Industry

It would not be possible to assess the growth potential of New Zealand's beef industry without considering the sheep industry because of the close relationship between the two. As mentioned earlier, most beef cattle in New Zealand are found on sheep farms. Historically, beef cattle raising was complementary to sheep raising; now, beef cattle are being raised on their own account as sources of income competitive with sheep production.

8/ Defined in terms of primary function; comprised mostly of Jerseys (74 percent) and Holstein-Friesians (22 percent) (174, 1971/72). Beef cattle are mostly Angus (75 percent) and Hereford (15 percent), (28, p. 117; 174, 1970/71, p. 19).

The structure of New Zealand's sheep industry varies widely, ranging from farms that produce wool as practically their sole product to those capable of fattening for sale all stock carried. Sheep farm carrying capacities vary from 1 sheep per 10 to 12 acres in the South Island high country to 6 or more sheep per acre on greatly improved topdressed pastures (app. F). About three-fourths of all sheep are of the Romney breed.

Livestock Products

During 1960-70, total meat production in New Zealand rose 37 percent (3.15 percent a year) from 753,000 tons in 1960 to over 1 million tons in 1970 (app. table 3). Most of the growth came from a 69-percent increase in beef production, which rose from 213,000 to 361,000 tons (4.9 percent a year). Veal production was variable but generally static. Lamb and mutton production increased 31 percent, from 272,000 to 357,000 tons (2.5 percent a year). In 1972, beef production reached 385,000 tons, and beef and veal, 405,000 tons.

Milk production rose slowly in the 1960's, increasing 23 percent, from 1,121 million gallons in 1959/60 to 1,377 million gallons in 1968/69. Production declined to 1,276 million gallons in 1969/70 and to 1,273 million gallons in 1970/71 following a severe drought, but recovered to 1,339 million gallons in 1971/72 (app. table 4). Between 1960 and 1970, production increased at a trend annual rate of 2.1 percent.

Butter and cheese production substitute for each other. In the 1960's, output of butter was favored, with production rising about 13 percent to a record 267,000 tons in 1969. However, production then declined to 245,000 tons in 1971/72. Cheese production reached a record 110,000 tons in 1968 and then began falling, reaching 103,000 tons in 1971/72 (app. table 5).

Production of skim milk powder (SMP) and casein, two byproducts of butter manufacture, increased considerably in the 1960's. SMP output in 1971/72 was almost five times that of 1959/60, and casein production was 60 percent greater. The 1960-70 annual trend growth rate for SMP was 14.1 percent, and for casein 8.8 percent.

Wool production rose 25 percent from 577 million pounds to 723 million pounds between 1960 and 1970, and then reached a record 736 million pounds in 1970/71. Most of the increase resulted from the increase in sheep numbers, but with more emphasis on fat lamb production, average fleece weights also increased and percentage of fine wool declined.

III. ECONOMIC TRENDS AND PRODUCTION ALTERNATIVES

This chapter discusses economic trends in New Zealand's livestock production in the 1960's; examines the economic position of the beef, dairy, and sheep industries; and evaluates the relative profitability of beef production versus dairy and sheep production. The technological and institutional factors affecting the beef and dairy industries are discussed in chapters IV-VI. World market conditions affecting New Zealand livestock production are discussed in chapter VIII.

Prices

In the 1960's, economic trends favored expansion of beef production in New Zealand and moderated growth in dairy and sheep production. Prices for beef increased at a faster rate than for other livestock products, reflecting the rise in world demand for beef. Veal and lamb prices also showed sizable increases, but dairy product prices increased only slightly and wool prices declined.

Beef

Meat exporters' opening schedule prices for North Island beef (the major part of New Zealand's beef supply) show that prices increased for every class of beef in the 1960's (table 4). The price of ox beef (680 pounds or under, carcass weight) rose from $13.50 per 100 pounds in 1959/60 to $21.50 in 1969/70 and to $22.50 in 1970/71, with only one sizable slippage, in 1961/62.

Lamb and Wool

Prices for lamb (and mutton) were generally favorable and influenced greater production in the 1960's. However, prices for wool, the complementary product, edged down in mid-decade, and profitability of sheep farming began to depend on the relative proportions of income derived from wool and meat (tables 5 and 6).

Dairy Products

Milk prices to the farmer in the 1960's were generally stagnant or in decline (table 7). Nevertheless, the number of milk cows increased steadily, partly because of productivity increases in dairying and protective Government policy (chs. IV-VI). Although beef prices were rising during the decade, there was little shifting out of dairy and into beef production until the late 1960's. Beef raising did not appear to be a conspicuously profitable or attractive alternative until that time (124; 235; and the economic studies surveyed below). The price of butterfat (including returns from nonfat sales) picked up in 1971 and reached 50.21 cents per pound (equivalent to 2.36 cents a pound of milk) in the 1971/72 season as world market conditions improved.

Export Prices

Wholesale price trends in the London market (the major market) for New Zealand butter, cheese, wool, and lamb follow closely the domestic New Zealand schedule prices and clearly indicate the external trade dependence of domestic prices (app. table 6).

Table 4.--Meat exporters' opening schedule prices for beef, North Island, New Zealand, 1959/60-1971/72 1/

Type of beef, quality, and carcass weight in pounds	1959/60	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72
	Dollars per 100 pounds												
Ox beef, GAQ & FAQ, 2/, 3/													
680 & under	13.50	14.00	11.50	13.50	12.50	15.00	15.00	15.50	14.00	18.00	21.50	4/22.50	5/23.50
681-740	13.00	13.50	11.00	13.00	12.50	15.00	15.00	15.50	13.50	17.50	21.00	22.00	6/25.00
741-800	12.50	13.00	10.50	12.00	11.50	14.00	14.00	15.00	13.00	17.00	20.50	21.00	
801 & over				10.50	10.00	12.50	12.50	13.50	12.00	16.00	19.50		
Heifer beef, GAQ & FAQ, 2/													
560 & under						14.50	14.50	14.50	13.00	17.00			7/22.00
561 & over						13.00	13.00	13.00	11.50	15.00			
500 & under											20.50	4/21.50	8/24.00
501 & over											18.50	19.50	22.00
Cow beef, GAQ, 2/													
600 & under	11.00	11.00	9.50	10.50	10.00	11.26	12.00	12.50	12.50	15.50			
601 & over	10.00	10.00	8.00	9.00	8.50	9.50	10.26	11.00	11.00	14.00			
550 & under											19.50	20.50	
551 & over											17.50	18.50	9/19.00
Boner beef (cull cattle):													
Average all weights	13.00	11.00	10.00	10.00	10.00	10.50	11.25	14.00	12.00	17.00			
280 & under											18.50	19.00	19.00
281 & over											19.50	20.00	21.00

Blank space means classification not available.

1/ Prices quoted are those first offered by exporters after October 1 in each season.
2/ GAQ = good average quality; FAQ = fair average quality.
3/ GAQ only, 1959/60-1963/64 season.
4/ All weights of FAQ ox quoted at $22.00; all weights of FAQ heifer quoted at $21.00.
5/ 450 and under.
6/ 451 and over.
7/ 400 and under.
8/ 401-500.
9/ FAQ, 281 and under.

Source: (194,1962/63-1971/72).

Table 5.--Meat exporters' opening schedule prices for lamb, North Island, New Zealand, 1959/60-1970/71 1/

	1959/60	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66
Price in cents per pound	11.25	17.08	13.95	14.16	16.25	18.74	17.50
	1966/67 2/	1967/68 2/	1968/69 2/	1969/70 2/	1970/71 2/	1971/72 2/	
Price in cents per pound	12.92	11.7	14.7	21.8	20.0	3/12.4	

1/ For prime lamb, 29/36 lb. weight.
2/ Not comparable with 1966 and earlier seasons. Prices quoted are for meat only; there is an additional payment for the skin (pelt and wool).
3/ The low opening price led to intervention by the Meat Producers Board at a minimum price of 14 cents.

Source: (194, 1963/64, 1967/68, 1971/72).

Table 6.--Average price of wool (greasy, all qualities) at New Zealand auctions

	1959/60	1960/61	1961/62	1962/63	1963/64	1965/64	1965/66
Price in cents per pound	37.2	33.6	32.7	35.7	45.9	35.1	34.7
	1966/67	1967/68	1968/69	1969/70	1970/71		
Price in cents per pound	29.3	22.9	28.1	25.6	24.2		

Source: (200, 1970/71).

Table 7--Average prices for butterfat and for milk paid to suppliers of dairy companies in New Zealand, 1956/57-1972/73

Season	Price per pound of butterfat 1/		
	(in cream, at farm gate) for butter making 2/	(in milk, at factory door) for cheese making	Equivalent price per pound of milk 3/
	Cents		
1956/57	31.29	33.79	1.57
1957/58	30.20	32.71	1.53
1958/59	26.67	29.17	1.37
1959/60	30.33	35.33	1.65
1960/61	26.66	31.67	1.49
1961/62	26.66	31.67	1.48
1962/63	26.66	30.83	1.44
1963/64	27.91	32.08	1.51
1964/65	29.08	34.91	1.64
1965/66	28.25	37.59	1.80
1966/67	28.25	37.62	1.79
1967/68	26.59	35.05	1.65
1968/69	26.59	32.62	1.53
1969/70	26.59	33.61	1.57
1970/71	27.85	37.94	1.78
1971/72	29.05	50.21	2.37
1972/73	32.28	50.68	2.40
1973/74 (interim)	32.16	n.a.	n.a.

1/ These are prices that the average dairy companies would be enabled to pay suppliers on the basis of "basic purchase prices" paid to the companies by the New Zealand Dairy Board, for butter and cheese for export plus allowances for returns from other dairy product exports (mainly casein and milk powder). Beginning 1965/66, prices are "final prices" for the season; prices for earlier years are the total of advance prices plus any surplus payments authorized. See Chapter VI for further details on pricing and returns to producers.

2/ Beginning 1972/73, prices are for butterfat in milk, at factory door.

3/ App. table 4 gives average butterfat content per pound of milk.

Source: (187; 174, 1965/66, 1970/71-1972/73).

Table 8.--Index numbers of export prices, New Zealand, 1959/60-1970/71 1/
(1959/60 = 1,000)

Year or period	Butter	Cheese	All dairy produce	Meat	Wool	All pastoral and dairy produce	All exports
1960/1961	896	991	927	992	948	955	957
1962 . . .	968	995	972	805	930	936	938
1963 . . .	1,095	986	1,048	1,003	1,003	1,009	1,008
1964 . . .	1,181	962	1,100	1,066	1,270	1,147	1,138
1965 . . .	1,226	1,038	1,185	1,226	987	1,123	1,119
1966 . . .	1,105	1,034	1,136	1,198	979	1,119	1,113
1967 . . .	1,049	1,036	1,095	1,199	873	1,054	1,052
1968 . . .	1,077	1,146	1,140	1,308	677	1,019	1,022
1969 . . .	1,096	1,160	1,138	1,424	825	1,125	1,130
1970 . . .	1,099	1,158	1,130	1,583	767	1,143	1,149
1971 . . .	1,153	1,256	1,207	1,659	717	1,174	1,186

1/ Year ending June 30.
Source: (189, May 1972 and March 1973).

Table 9.--Average f.o.b. value of New Zealand's meat exports,
1960 and 1965-70

Calendar year	Beef and Veal	Lamb	Mutton
	Dollars per ton		
1960	450	330	118
1965	500	416	190
1966	596	376	196
1967	635	360	205
1968	804	427	205
1969	853	487	204
1970	924	487	277
1971	1002	478	249

Source: (200, 1969/70, 1971/72).

For New Zealand cow beef, the average wholesale price in the United States (the major market) rose rapidly during 1965-71 (200, 1971):

Year	Price
	N.Z. cents per lb.
1964/65	27.1
1965/66	31.0
1966/67	33.0
1967/68	38.2
1968/69	45.4
1969/70	48.4
1970/71	49.1

Indices of 1970/71 export prices for dairy products, meat, and wool show 115, 163, and 73, respectively, from a base of 100 in 1959/60 (table 8). During the 1960's, export prices of beef and veal rose faster than those of lamb and mutton. The average f.o.b. value (dollars per ton) of New Zealand's beef and veal exports more than doubled (table 9).

Income

Gross Farming Income

Data are based on information in the Gross Farming Income series, published by the New Zealand Department of Statistics (now Ministry of Agriculture and Fisheries). The series is "intended to afford an indication of the alternative returns available to farmers as a whole, from the production of particular products, to meet current expenses of farm operation, interest payments and other costs and to provide an income for themselves and their employees" (187). The data do not show aggregate net income after all expenses of farm operations have been met. Sales commissions, producer board levies, and other charges forming part of the finished products' value but not of returns to farmers are excluded, as are interfarm livestock sales. Series are published for beef, dairying, mutton and lamb, wool, and other farm activities. The beef series includes the value of all cattle slaughtered for meat except bobby calves. Vealer calves (not bobbies) and dairy herd culls are included. Dairy products are valued at the farmgate and costs of milk transportation to factories are deducted. The largest item in the dairy group is the payout to suppliers during the season by factories producing butter, cheese, dried milk, and other dairy products. Estimates of the value of raw milk for human consumption at farmgate prices are included, as well as the value of bobby calves slaughtered.

In the 1960's, gross farm income from beef production in New Zealand increased more steadily and at a faster rate than income from alternative livestock production.

Gross income from beef rose from $68 million in 1959/60 to $211 million in 1970/71, exceeding the growth rate of beef production, with growth especially rapid in 1967-71 (table 10). During the decade, gross income from beef production increased 160 percent, compared with (an unsteady) 16 percent for dairying, 90 percent for mutton and lamb production, and a fall in income from wool production. Despite a continued rise in volume of wool output, wool prices declined sufficiently to reduce gross income over the decade.

Per Unit of Production

Indices of value of production based on the Gross Farming Income series are shown in app. table 7, together with production volume and per unit returns (quotient of the value/volume ratio). Again, the per unit returns are not net of cost, but a persistently strong trend would give a fairly good idea of relative profitability.

Per unit returns from beef production almost doubled between 1960/61 and 1969/70. Returns on mutton and lamb declined in the late 1960's as a result of price downturns but then increased in 1969/70. Wool unit returns in 1969/70 were about 30 percent less than in 1960/61 and almost half the high level of 1963/64. Per unit returns to dairying fell considerably after 1966/67 and did not recover until 1970/71.

Costs

Production costs of the major pastoral products rose steadily during the 1960's, but without great differences in trend, so prices and gross returns were the dominant factors influencing investment. An indication of cost movements for sheep and dairy farms (not product groups) is given in app. table 8. Over the 10-year period, the differential in overall cost increases was only 2 percentage points.

Off-farm processing and marketing costs also sharply increased. Charges on lamb from farmgate to the (U.K.) Smithfield market rose 63 percent between 1960/61 and 1970/71. About half the increase occurred in the last 2 years--largely from higher charges between farmgate and f.o.b., which jumped 26 percent in 1970/71 alone (app. table 9; 172, 1971). Charges on wool from farmgate to mill increased 31 percent in the 10-year period (172, 1971). Dairy off-farm freight costs increased markedly after 1965 (app. table 10).

Terms of Exchange

Indices of dairy and sheep farmers' terms of exchange--the ratio of prices received to prices paid--measure changes in the purchasing power of a unit of output (a composite unit derived by weighing the proportional contribution to gross income of a range of products). Dairy farmers' terms of exchange fluctuated year to year during the 1960's, but stayed below 1,000 (the 1960/61 base) after 1967/68 (app. table 11). Sheep farmers' terms of exchange were buoyed up by high beef, lamb, and mutton prices and by the increasing proportion of income received from meat. Higher costs lowered the terms of exchange in 1970/71 (app. table 12; 172, 1971).

Results of Income and Expenditure Surveys

Income and expenditure surveys for sheep and dairy farming are made annually by the New Zealand Department of Statistics, the Economic Service of the Meat and Wool Boards, and the Dairy Board. These provide considerable information on economic structure and financial condition. However, there is no survey of beef farming per se, and

Table 10.--Gross farming income for selected farm product groups, New Zealand, 1960/61-1970/71

Season	Beef	Dairy	Mutton and lamb	Wool	Grain and field crops	All farm products
			Million dollars			
1959/60	67.9	187.4	99.3	169.5	39.2	625.5
1960/61	55.0	184.5	109.1	158.3	42.3	613.9
1961/62	59.7	175.9	92.6	153.9	42.2	595.0
1962/63	68.8	180.5	107.8	180.5	43.3	654.0
1963/64	74.4	198.3	131.3	230.1	50.0	763.6
1964/65	87.1	229.4	166.9	172.9	48.7	792.1
1965/66	95.7	241.8	166.9	193.6	51.1	852.5
1966/67	103.9	261.4	140.4	162.7	58.6	824.2
1967/68	121.6	242.5	155.8	131.6	66.9	817.9
1968/69	141.8	237.5	168.5	155.8	74.1	885.6
1969/70	176.7	217.3	188.3	139.4	60.0	893.8
1970/71	211	243	186	124	72	961

1/ Includes income from other farm products not specified.

Source: (188, 1962/63; 191, 1969/70).

because of an absence of cost accounting by product groups, the survey of sheep farming (inclusive of beef enterprises) offers limited insight into the economic structure of beef production.

Sheep Farmers

The survey of sheep farmers' incomes, made by the New Zealand Department of Statistics, has a definitionally consistent series starting 1960/61. The survey is intended to show representative average figures of the income and expenses of sheep farmers (not sheep farms). Farms owned by companies, partnerships, estates and similar enterprises are excluded from the survey. Farmers eligible for inclusion are those with a minimum average flock of 500 sheep and a gross income from sheep, cattle, and other products normally associated with sheep farming amounting to at least 75 percent of gross farm income.

The average sheep farmer's net income (subject to taxation) in 1969/70 was about 12 percent higher than in 1960/61 (app. table 13). "Profit from sheep" increased 78 percent during the period, and in absolute amount it increased about $2,800--more than profits associated with other sheep farming activities. 9/ Profit from cattle (beef) increased 115 percent, about $1,300. Sheep and cattle together accounted for practically all the increase in gross income. Profit from wool remained approximately the same, only because volume of sales increased at about the same rate that price decreased.

Expenses absorbed the increase in sheep and cattle income at the end of the 1960's leaving net income with only a slight increase by 1969/70. Income from cattle accounted for 17 percent of total gross income in 1969/70, compared with 11 percent in 1960/61.

Dairy Farmers

The survey of dairy farmers' incomes by the Department of Statistics is counterpart to that for sheep farmers. A consistent series is available beginning 1959/60. The survey is restricted to dairy factory suppliers. Town milk suppliers (who account for 10 percent of total production) are excluded. To be eligible for inclusion in the survey, a farmer must derive at least 90 percent of his total gross income from the sale of dairy products (including pigs).

Average net income of dairy farmers was about $3,300 in 1960/61, reached a high of $4,300 in 1966/67, and then fell to $3,900 in 1969/70 (app. table 14). Average expenditures rose by over $2,500 during the period, exceeding the rise in gross income from dairy products. However, income from livestock production (mainly from sales of cull cows for manufacturing beef and bobby calves) increased rapidly after mid-decade as dairy/beef enterprises (dairy/beef sales) started to take hold.

Sheep Farms

The Meat and Wool Boards' Economic Service carries out a survey focused on sheep farm, not farmer, income. Coverage of farms is by class (type of land) in both the South Island and the North Island, making possible time trend comparisons by class of farm (see app. F for a description of farm classes). For any one year, however, cross section comparisons between farm classes can be misleading. For instance, comparisons

9/ "Profit from sheep" is a misnomer. In fact, it is gross income, not net of expenditures. The gross income series given in this survey differs from the gross income series used earlier. The earlier gross income series related to farm product--an aggregate series derived not solely from surveys of sheep farmers.

of rates of return on capital would be perfectly valid as a measure of economic efficiency only where the proportions of capital, land, and labor are not variable between farms in the different classes (120).

A comparison of 1959/60 and 1969/70 sheep farm surveys shows: (1) a drastic decline in the rate of return on capital for all farm classes; (2) lower incomes, but a big increase in income from cattle (beef), particularly in South Island and North Island hill country; and (3) a rise in income from lamb and a decline in income from wool. Incomes in 1969/70 were adversely affected by a severe drought. However, even in 1968/69, the rate of return on capital was much lower than in 1959/60, ranging from 4.2 to 5.3 percent (201, 1968/69; app. tables 15 and 16).

Factory-Supply Dairy Farms

The survey of factory-supply dairy farms was started in 1963/64 by the New Zealand Dairy Board. Comparability with the 1968/69 findings extends back to 1964/65. 10/ Appendix table 17 shows that the average dairy farm's net farm income reached a high of about $4,700 in 1966/67 and dropped to $4,100 in 1968/69. Earnings from cattle increased steadily as a percentage of total farm income. Labor expenses, almost doubling in the 5-year period, accounted for more than 15 percent of total farm expenses in 1968/69, compared with 12 percent in 1964/65. The New Zealand Agricultural Production Council estimated 1969/70 and 1970/71 income and expenses per factory-supply dairy farm as follows (172, 1971):

Year	Gross farm income	Farm expenses	Net farm income
		N.Z. dollars	
1969/70	12,720	8,010	4,710
1970/71	12,240	8,380	3,860

Comparison of Surveys

The net income figures given by the New Zealand Department of Statistics differ from those given by the Producer Boards primarily because of differing survey techniques and coverage. The absolute levels of income for farms are somewhat higher than for farmers, perhaps because partnerships, estates, and companies, which tend toward larger operations, are excluded from the farmer income series. The trends correspond, however; dairy net incomes declined after 1967; sheep net incomes rose between 1962 and 1964, receded, then began to recover at the end of the decade.

The net income figures "very probably understate the full return from farming" for the following reasons: (1) Tax concessions for investment in capital improvements are more generous in farming than in other businesses. To the extent capital expenditure is written off against income, there is underestimation of actual income. This could be considerable, particularly in sheep farming as dairy farming properties are already highly developed in some areas. (2) Land is the largest cost item on a farm, but over time its value increases and capital gains (not reflected in the income figures) can be made. (3) Part of certain expenditures--for a car, electricity, and a telephone, for example--are tax deductible and thus the published income figures are understated (172, 1970).

10/ Inclusion in the 1968/69 survey, however, was limited to farms with herd size of 30 cows or more, compared with 25 cows or more in 1964/65-1967/68 surveys.

Capital Expenditures

Production patterns and trends depend a great deal on capital expenditures. Annual surveys of farm capital expenditure have been conducted since 1965/66 by the New Zealand Department of Statistics and are summarized in appendix table 18. The figures do not include value of increased livestock numbers. Also, farms of less than 10 acres are excluded, and because about 5 percent of returns are not completed, the figures should be adjusted upwards to obtain an estimate of total capital expenditures.

The surveys indicate a continuing fall in overall capital expenditures during 1965/66-1969/70. Capital expenditure in beef farming rose, however, and particularly in dairy/beef farming, where capital formation more than doubled, increasing from about $500,000 in 1965/66 to $1.3 million in 1969/70. Investment by "primarily dairy farmers" held steady at $34-$35 million in 1965/66-1967/68, but declined to $28 million in 1968/69 and to $24 million in 1969/70.

Production Alternatives

The economics of beef production in New Zealand has only lately gained the attention accorded dairy and sheep production. Favorable prospects for beef exports, uncertainty in dairy and wool markets, and the rapid expansion of the beef herd in the 1960's have stimulated studies of comparative profitabilities among livestock enterprises.

In regard to these studies, it should be noted that beef production systems are still in flux, and scientific knowledge of beef production under New Zealand conditions lags far behind comparable knowledge on dairy and sheep. There is a wide range of possible entries into beef production, each requiring separate study with respect to integration into current management systems for dairy and sheep. Only in recent years have farmers adopted intensive methods of beef production on a large scale. Few farmers have achieved a "stable beef system," and only in the last few years have research stations started to provide experimental data on intensive beef production (134, 268, 128).

Investigations into the profitability of beef versus sheep and dairy production have indicated the following general conclusions: 11/

1. Dairying is still more profitable than beef cattle raising in the major dairying areas.

2. The rearing of dairy/beef calves, on dairy farms, until they are 4-5 months old is basically a supplemental activity requiring no displacement of milk cows and little competition for grass. If labor is available, this would be a profitable enterprise.

3. The price for butterfat (including returns from solids nonfat sales) would have to go below 28 cents per pound (at 1966/67 constant prices) to cause a major switch from dairy to beef production. (The milk price equivalent would be 1.32 cents a pound.) If this happened, dairy farms in Northland, Central Auckland, and Hawke Bay/East Coast--apparently the marginal dairying regions--would be the first to shift.

4. Beef enterprises can equal or exceed the profitability of sheep farming (40, 128, 121, 93). Beef fattening activities indicate

11/ See (155, 93, 122, 40, 128, 249, 121, 134, 125).

greater profitability but more speculative risk than beef breeding activities, particularly in the South Island. Overall, at price relationships existing after 1965, beef production appears more profitable and is expected to expand, but probably not at the expense of the sheep flock. Sheep numbers will be maintained, partly for flexibility of production.

5. The ability to save labor costs is a prime factor in the decision to increase beef cattle numbers at the expense of dairy cows or sheep. Beef enterprises will also continue to be established as a hedge against adverse markets for dairy and sheep products, and as offering an easier way of life for the farmer than dairying.

6. Most beef cattle enterprises are more capital intensive than sheep farms and this could be an important factor when finance is limited (128).

The studies from which these general conclusions are drawn are briefly summarized below. It should be recognized that these findings are subject to a great number of precise assumptions. 12/

Lewis/Stonyer (128, 1970).--Four beef policies "providing the basis of most beef production systems" are analyzed and compared with alternative production activities, by gross margin analysis. In beef policy A, cows are bred and weaners sold; in B, weaners are bought, and then sold at 20 months old; in C, steers are bought at 18-20 months old and sold at 2 1/2 years; and in D, calves are reared and sold at 4-5 months old. In general, policies B and C compare very favorably with sheep breeding and fattening policies and, in some cases, production under policies B and C will compete with cash crops and dairying.

Chetwin (40, 1968).--The study investigates the profitability of dairying versus various beef and sheep breeding and fattening activities (app. table 19). Dairy/beef fattening is found to compete in profitability with sheep activities, especially after allowing for the difference in labor inputs required. Under the given price, cost, and productivity assumptions, dairying would still be the most profitable enterprise.

Hughes/McClatchy/Hayward (93, 1971).--The study focuses on the South Island hill and high-country regions. About 20 percent of beef cattle in New Zealand are in the South Island and one-half of these are in the hill and high-country regions. Compared with cattle-sheep ratios in the North Island hill country, the ratios of cattle to sheep are much lower, though increasing faster. The analysis is from the point of view of a farmer planning increases in stock units and having to choose between cattle and sheep. Profitability per acre was used to compare alternatives, because land is generally the most limiting resource. At the prices used, beef and sheep activities appear to be roughly equal in profitability, in most areas. If beef cattle are chosen, they will be additional to, rather than displacing, the existing stock of sheep. Where profitabilities of cattle and sheep are similar, the farmer with a 50:50 cattle to sheep ratio would be in a more sound and stable position than one with mostly one or

12/ Gross margin analysis and linear programming (LP) techniques were employed. Gross margin is the difference between the additional revenue and additional direct (variable) cost associated with a new activity undertaken by a going concern. The gross margin is used to pay for part of fixed costs (e.g., rent) of the total enterprise, and the residual contributes toward net profit (93). Analysis based on gross margins is appropriate for marginal changes; the capital structure is assumed to remain about the same and large changes in feed demand and supply are not forthcoming (149).

the other. The authors conclude that the less risky situation of having balanced numbers of cattle and sheep would be sufficient to make cattle increases more economically justifiable than sheep increases on most properties.

Stichbury (249, 1971).--This analysis compares dairying with two alternative beef policies. The basic assumption is that a farm producing 300 pounds of butterfat per acre (about 6,400 pounds of milk) could expect to produce 450 pounds carcass-weight of beef. Gross income per acre for dairying was estimated to be $118.90:

Milk sales--6,400 lb. @ 1.64¢ per lb.	=	$105.00
Cull cows--.15 @ $50 per head	=	7.50
Cull bull--.01 @ $100 per head	=	1.00
Bobby calves--.60 @ $9 per head	=	5.40
		$118.90

In beef policy A, weaners are bought, and then sold as steers at slaughter weight. Production of beef per acre is 450 pounds (from 1½ animals). Adding 180 pounds of (weaner) beef bought-in gives 630 pounds. Total value at $21.00 per 100 pounds of beef would be $132.30. Subtracting $60.00 (cost of 1½ weaners) results in a gross income of $72.30. In beef policy B, bulls are reared and sold as beef cattle for slaughter. Gross income per acre is $91.20. Thus, dairying would provide about $47 more per acre than beef policy A and $28 more per acre than beef policy B. Stichbury estimates that capital cost savings from beef production (breeding and testing, animal health, sheds, electricity, and other costs) would be only $5.70 per acre, so that very high weights of beef per acre (736 pounds under policy A and 586 pounds under policy B) would have to be produced to equal returns from dairying. However, in some cases, labor savings could considerably narrow income differences.

Kingma (122, 121, 1968).--Linear programming was used to explore relative profitability, investment requirements, and organizational changes associated with integrating beef cattle production into the farming pattern in the Canterbury Plains (South Island). Integration of arable cropping with prime lamb and wool production was so much more profitable in the past that the inclusion of beef farming was not justified. In recent years, however, beef cattle numbers in the area have increased steadily.

The study determined that substantial substitution of beef cattle for sheep would start at a beef price of $13.70 per 100 pounds. Beyond $15.00 per 100 pounds, the greater number of cattle raised would be accompanied by bought-in hay. At $16.00-$17.00 per 100 pounds, beef would begin to displace cropping. Feed supply was the principal concern of farmers considering increases in their beef herds. (Livestock policies relied on grass and grass products as a basis for production). Eighty percent of the farmers in the study cited low labor requirements as one reason for running cattle, and most claimed that cattle allowed better overall utilization.

Lowe (134, 1971).--This is a study of the profitability of beef production on New Zealand sheep farms that are conducive to intensive beef and sheep farming. The coverage would include most lamb fattening farms but would exclude dry-sheep farms. Only beef fattening (nonbreeding) policies were considered.

Data from a farm survey were used in a linear programming model. The survey indicated:

(1) Labor input on the lamb fattening farms varied widely and no conclusions could be drawn on the optimum labor input for beef production systems.

(2) The ability to save labor costs was a reason many farmers increased beef numbers at the expense of sheep or dairy cows. In terms of stock-equivalent numbers, it was generally accepted that labor requirements are lower in beef

cattle production than in sheep and dairy cows production. Some farmers shifted to beef simply to have more leisure time.

(3) Management skills most critically needed for profitable beef farming are purchasing ability and skillful feed-budgeting.

(4) Most farmers expressed a "working capital" problem because of the fairly long time lag prior to recovery of the farmer's capital outlay on stock.

A "slow" growth pattern (stocking two beef animals per acre) was defined for beef cattle fed sparely; a "fast" growth pattern (one and a-half animals per acre) meant a much higher plane of nutrition, particularly over the winter. The following conclusions were made:

(1) At beef and sheep prices experienced "over the last few years, and could reasonably be expected in the future," sheep farmers could make substantially more profit from beef animals than breeding ewes. A beef price of $20 per 100 pounds and a sheep price of $8 per ewe were assumed for both case farms, and these prices brought an income per acre of $51.60 to $56.90 for an all-sheep system, $61.80 to $64.70 for a "slow" beef cattle policy, and $84.10 to $94.60 for a "fast" beef cattle policy.

(2) Hay, silage, or grain feeding should be kept to a minimum. Grain feeding was not profitable when beef prices were below $30 per 100 pounds. Only under special circumstances, such as to prevent high animal mortality rates or when a cheap source of grain was available, would meal feeding be profitable.

(3) The pattern of feed availability can affect the price range over which sheep and beef animals can be profitably farmed together. A farmer with a greater production of pasture in the spring relative to other seasons has a much wider range of beef prices over which joint beef and sheep production is feasible.

Lattimore (125, 1970).--Using linear programming, the study explores the comparative profitability of milk and beef production on dairy farms. The analysis is restricted to substitution between beef cattle and dairy cows, at the prevailing stocking rate. Case studies for the analysis represented different resource structures with respect to farm size, soil type, climatic conditions, owner's equity, managerial skills, and labor inputs. Lattimore concludes that there is a marked difference in the milk-to-beef price ratio at which farmers can profitably make the change, depending on the farm resource structure:

(1) When there is sufficient labor to rear extra calves, or when the manager is prepared to work harder to increase net farm profit, the production of beef weaners (calves about 4 months old) could be a profitable supplement to dairying. Profitability will depend on the price difference between bobby calves and weaners, and in the programming model, a $17-difference was found sufficient. In 1969, the actual difference was $22 to $25, so beef weaner production on these farms should continue as long as the demand for dairy-bred weaners persists. The demand for dairy-bred weaners, in turn, can be expected to continue, provided beef schedule prices (table 4) remain at a high level ($20 per 100 pounds, or higher).

(2) For farms with greater resource constraints, particularly labor constraints, net revenue could be increased by adopting a mixed beef-dairy policy--that is, by reducing dairy cow numbers, retaining surplus calves for rearing, and purchasing additional store beef cattle (calves and weaners). However, at 1969/70 prices (32 to 33.5 cents per pound of butterfat--equivalent to 1.5 to 1.6 cents per pound of milk--and $20 to $21 per 100 pounds of beef), the increase

in net revenue would be small. Without the $10 per head dairy/beef incentive payment (ch. V of the present report), the beef price would have to increase to $25.50 to permit the marginal shift from milk production to beef, assuming the milk price remained at about 1.5 cents. The change from all-dairy to a mixed beef-dairy system would reduce requirements for hired labor.

(3) For the three case farms studied, a change to all-beef farming is feasible if sufficient calves and/or weaners can be obtained; but at 1969/70 prices, net farm revenue would be lower. Depending on the farm's fixed charges, the farmer's age, and his willingness to sacrifice a margin of income for more leisure time, an all-beef enterprise might still be undertaken.

Meister (155, 1971).--Linear programming models were developed to examine supply response of the New Zealand dairy industry to changes in the price of butterfat (in milk, at factory door; includes returns from solids nonfat). Patterns of supply response in terms of dairy output and adoption of dairy/beef activities were traced out on a regional and national basis. The analysis was confined to factory-supply dairy farms earning more than 80 percent of their income from dairying. These farms produced 93 percent of total dairy output in the North Island in 1966/67 (base year for the study), and the study results were considered to apply to the whole industry.

Dairy/beef production was chosen as the alternative enterprise to dairying for several reasons. The beef price was expected to increase relative to the milk price. Beef production fitted in best with the existing dairy enterprise with respect to management and fixed costs. Further, the Government had indicated the suitability of dairy/beef as a short-term alternative (155, pp. 33, 37, 121).

Five different dairy/beef activities were incorporated into the model: (A) rear calves to 8-10 weeks of age, and sell; (B) rear calves to 4-5 months, and sell; (C) rear bobby calves to 18-20 months, achieving slaughter weight in this period, and sell; (D) buy weaners 8-10 weeks of age, rear to 18-20 months, and sell; (E) buy weaners 4-5 months of age, rear to 18-20 months, and sell. To stay within the assumption of fixed costs remaining constant, an increase in the stocking rate was not allowed. Except in cases (A) and (B), adoption of dairy/beef activities would require displacement of milk cows.

Prices taken for the study were the following: (1) For the weaner breeding activities, leading to weights of 180 and 280 pounds, respectively, a price of 14 cents per pound liveweight; (2) a beef schedule price of $21.50 per 100 pounds; (3) a price of $13.00 a head for bobby calves suitable for beef rearing; (4) a butterfat price of 32.5 cents per pound (equivalent to a milk price of 1.6 cents a pound), with alternatives of 27.5 cents and 22.5 cents per pound of butterfat (equivalent to 1.3 cents and 1.1 cents per pound of milk).

At the 32.5-cent butterfat price, the study shows that beef production as an alternative to dairying would not be adopted. The industry would restructure itself toward producing more milk and fewer, larger, and more efficient farms. The less the constraint on amalgamation toward fewer farms, the greater the quantity of milk produced. At a butterfat price of 27.5 to 32.5 cents per pound, dairy production is highly inelastic; on many farms dairying would still be the most profitable enterprise. At the 22.5-cent butterfat price, and with no constraint on optimal industry structure, dairying would be so unprofitable that dairy/beef enterprises would disappear and almost 1.3 million acres of dairyland would be in disposal.

IV. PRODUCTION TECHNOLOGY

New Zealand's livestock industries are, overall, highly efficient and competitive even at great distances from major markets. However, further advances in productivity have become a pressing requirement because of labor scarcities and rapidly rising production and marketing costs. The dairy industry is undergoing rapid structural transformation, and large-scale, intensive beef production is new, with major advances in production technology still to come.

Technological advances are defined broadly in this chapter to include improvements in management and in physical means of production. Productivity trends are first delineated for the dairy and sheep industries (the productivity measure for beef production is available only in terms of sheep operations). Then, technological factors for increased productivity are surveyed, and prospects for further advances and adoption are indicated.

Productivity Trends

Less labor is now required per unit of output in New Zealand sheep and dairy farming. During 1960-70, total cattle numbers increased 46 percent, milk cows increased 23 percent, and sheep numbers rose 28 percent. At the same time, land use did not increase, but employment in livestock farming declined. The census of population for 1966 compared with that for 1961 shows that employment in dairy farming dropped from 41,700 to 39,500 and in sheep farming, from 39,100 to 38,500 (187, 1971). Other information, while not based on data beyond 1966 census figures, also suggests that productivity, as measured by labor input, has increased (34).

Sheep Farms

In all farm classes except one (mixed cropping and fattening farms in the South Island), meat output--especially beef output--per acre increased during the 1960's (table 11). Size of farm and number of labor units per farm increased slightly in the South Island, but decreased somewhat in the North Island. That North Island farms give evidence of higher labor and land productivity--as indicated by decreased inputs and increased output per farm--could be deceptive in terms of the labor units, however, because of the possibility of greater intensity of labor use (34).

Dairy Farms

Milk production per farm, per acre, and per labor unit is rising in New Zealand. Several factors are contributing to this increased productivity. Dairy farms are fewer but larger in terms of acreage and size of dairy herds. Stocking rates are higher. Milking shed designs are being improved. Artificial insemination is advancing, with changes in the type of breeds used, resulting in more extensive herd improvement (51).

Fewer herds, fewer dairy farms, greater production.--In the 1960's, the number of dairy herds (10 or more cows) fell from 31,150 to 23,750. In the same period, suppliers to dairy factories dropped from 36,700 to 23,700 or 35 percent, while milk production per supplier rose almost 50 percent 344,700 to 512,800 pounds (and to 540,000 pounds in the nondrought year 1968/69) (table 12).

Table 11--Labor units, meat output, and beef output, by size and class of sheep farm, New Zealand, selected years

Item	Year	Class of farm 1/							
		1&2S	3S	4Se	4Si	5S	2N	3N	4N
Average acreage per farm (in 1,000 acres)	1969/70	30.6	4.1	0.9	0.5	0.5	2.2	0.9	0.5
	1959/60	29.6	2.8	0.8	0.3	0.5	2.6	1.1	0.5
Average labor units per farm (in man-years)	1969/70	3.8	2.4	2.1	1.8	2.2	2.8	2.1	1.8
	1959/60	3.3	2.1	2.0	1.7	2.1	3.2	2.2	2.0
Average meat production per farm (lb.)	1969/70	3.4	24.6	83.6	170.9	75.5	70.4	105.4	157.7
	1959/60	2.4	20.9	75	174	78	53	81	154
Average beef production per farm (lb.)	1969/70	0.9	7.1	13.6	17.5	3.2	30.4	37.5	52.7
	1968/69	0.8	7.1	15.2	15.4	6.5	28.0	35.9	54.1
	1959/60	0.4	2.5	9	11	9	25	30	50

1/ See Appendix F for definitions. Source: (120; 201)

Table 12--Number of dairy herds, number of suppliers to factories, and dairy production per supplier, New Zealand, selected years

Year	Herds 1/	Factory suppliers 2/	Butterfat production per supplier 3/	Equivalent milk production per supplier 4/
	Number		Pounds	
1960/61	31,150	36,700	16,200	344,700
1964/65	27,547	29,700	21,200	451,100
1968/69	24,606	25,000	25,400	540,400
1969/70	23,750	23,700	24,100	512,800

1/ Herds of 10 or more cows; includes both factory-supply and town-supply herds (175, 1969/70, p. 69).
2/ Factory suppliers with one or more cows.
3/ Factory suppliers with herds of 10 or more cows.
4/ Based on 4.7 percent butterfat-in-milk content.
Source: (174, 1971; 175, 1969/70).

Increased output per labor unit.--Advances in labor productivity are critical to dairy farming in New Zealand as alternative work opportunities and sociological factors have tended to draw labor away from dairying. However, further amalgamation of farms and advancing technology will most likely lead to greater efficiencies in labor use. In the brief period between 1964/65 and 1968/69, the number of cows milked per labor unit (in factory-supply farms with 30 or more cows) increased from 53 to 68, while annual butterfat output per labor unit rose from 16,560 to 19,130 pounds (equivalent to an increase from 352,300 to 407,000 pounds of milk) (177, 1968/69).

Increased butterfat production per farm and per acre.--Average annual butterfat production per farm rose 40 percent from 18,100 pounds (equivalent to 385,000 pounds of milk) in 1960/61-1964/65 to a record 25,300 pounds (equivalent to 538,300 pounds of milk) in 1968/69 (app. table 20). (Drought-affected production in 1969/70 was 24,100 pounds of butterfat or 512,800 pounds of milk per farm.) And in South Auckland, butterfat per farm averaged 30,700 pounds or 653,200 pounds of milk in 1968/69.

Annual butterfat output on farms where artificial insemination was used averaged 29,050 pounds (618,085 pounds of milk), compared with 22,460 pounds (477,872 pounds of milk) on farms where it was not used (app. table 21). However, this is not a measure of the benefits of AB alone because other factors (for example, high stocking rates) were associated with AB users (175, 1969/70, p. 24).

Butterfat output per acre (for factory-supply dairy farms with herds of 30 or more cows) increased about 10 percent between 1964/65 and 1968/69 (177):

	Butterfat	Milk equivalent
	Pounds per acre	
1964/65	176	3745
1965/66	185	3936
1966/67	197	4191
1967/68	187	3979
1968/69	194	4128

The potential for future increases in output per acre is suggested by the fact that 700 pounds of butterfat per acre (14,890 pounds of milk), and an average 500 pounds per acre (10,640 pounds of milk) over a number of years, has been achieved at New Zealand's Ruakura Agricultural Research Station. Some commercial farmers are producing about 400 pounds of butterfat per acre (8,510 pounds of milk). About 10 percent of factory-supply farms (30 or more cows) were producing 300 or more pounds per acre (6,385 pounds of milk) in 1964/65 and this percentage increased to 16 percent in 1968/69 (177, p. 32; 310).

Milk per cow.--Over the 1960's, milk output per cow was generally static, with some variability due mostly to seasonal influences (app. table 22). However, in New Zealand, milk output per cow is misleading as a productivity indicator of dairy farm operations. In the first place, because land is generally regarded as the most limiting factor of production in New Zealand, the trend has been toward higher stocking rates and maximization of outputs and revenues per acre rather than milk per cow. In a tradeoff between greater milk per cow or more cattle per acre (with less milk per cow), the usual economic advantage would be toward more cattle per acre (up to a point). In recent years, with beef prices rising relative to dairy prices, higher stocking in dairy farms has also meant more beef as well as dairy cattle per acre. Secondly, the use of large quantities of feed concentrates to raise milk yield per cow is still not profitable under New Zealand conditions (see "Potential for Use of Concentrates" below).

Factors Increasing Livestock Productivity

Fertilizer and Land Improvements

During 1961-70, grassland area topdressed with fertilizer expanded 45 percent in the North Island and 90 percent in the South Island 188, 1964/65; 191, 1969/70):

Area	1961	1970	Growth rate
	1,000 acres		Percent
North Island	6,578.2	9,550.3	45.2
South Island	2,319.1	4,416.4	90.4
New Zealand	8,897.3	13,996.7	57.3

In the same period, fertilizer and lime use increased 52 percent--from 1.9 million to 2.9 million tons (188, 1968/69; 191, 1969/70).

In recent years, applications of potash and the trace elements molybdenum and sulphur have increased significantly--especially in the South Island--as more knowledge of soil deficiencies has led to more selective fertilizer use (180, 1969/70). A study on fertilizer use in Southland links expansion of pastoral production with fertilizer demand and shows how fertilizer use has expanded at twice the rate of livestock numbers (113). Increased use of fertilizer was stimulated by buoyant economic conditions through the mid-1960's and as a result of the 1963/64 Agricultural Development Conference, which recommended a 7-percent annual increase in fertilizer use to achieve development targets. Other factors also contributed to land development: the oversowing of clovers (to fix nitrogen in the soil cheaply), the erection of fencing to contain stock and feed, and better pasture management (231; 137; 46).

Total area occupied for farming (and timber) actually decreased by 600,000 acres between 1961 and 1970, but area in sown grasses (improved grassland for pasture) rose almost 1.6 million acres, or to 47 percent of total area from 43 percent in 1961 (table 1).

New Zealand's hill country (particularly in the South Island) has been improved through topdressing with fertilizer and sowing with grassseed, and as a result, land use patterns are changing. Country formerly capable of producing only store stock can now produce finished stock for slaughter. This new use of hill-country land is also partly a result of demand for leaner meat. Animals that at the start of the 1960's were regarded as being only in store condition are now acceptable for slaughter. This recent use of the hill country fat livestock fattening purposes could eventually cause major exceptions to the traditional two-tier system of beef (and sheep) production and lead to greater diversification of farming in the low country (which would no longer have near-monopoly in the fattening of store cattle) (231).

Irrigation

Grassland area under irrigation expanded almost 30 percent during 1961-70 (188, 1968/69; 191, 1969/70):

Year	Irrigated grassland	Total irrigated area
	1,000 acres	
1961	171.1	190.7
1965	199.7	229.1
1970	217.7	273.6

Investigations into the economic feasibility of irrigation, particularly in the Canterbury and Otago regions of the South Island, are in progress. At the Winchmore Irrigation Research Station in Canterbury, experiments have indicated that nonirrigated pasture production averaged 5,360 pounds of dry matter per acre (a range of 2,650 to 7,860 pounds), compared with 10,550 pounds (a range of 9,350 to 11,890 pounds) for irrigated pastureland. In addition, production variability between good and bad seasons was reduced to ± 12 percent (of the mean) for irrigated areas from ± 48 percent for unirrigated areas. An important aspect that is claimed is the low cost associated with the high and predictable output (175, 1969/70). Like fertilizer, more extensive irrigation would likely alter the pattern of land use. In the South Island, as more calves become available in the foothills and high country, and as dry matter yields increase in easier country through more extensive irrigation, a greater concentration on beef finishing (and less breeding) will likely take place in easier hill country.

Mechanization

Mechanization of farm operations continued to advance in New Zealand in the 1960's as a result of labor scarcities, rising wages, and the potential efficiencies of larger capacity machines on larger farms (187, 1972; 191, 1969/70):

Machinery	1960	1970	Change
	Number		Percent
Agricultural tractors	78,415	95,502	21.8
Milking machines	36,721	27,930	-23.9
Shearing stands	61,637	71,055	15.3
Pickup balers	7,932	12,618	59.1
Side-delivery rakes	21,953	25,378	15.6
Harvesters:			
Forage	1,200	5,403	350.2
Header	4,746	5,724	20.6
Electric fence units	54,707	70,140	28.2
Field mowers	N.A.	52,005	N.A.
Ploughs	N.A.	42,101	N.A.
Disk harrows	N.A.		N.A.
Farm trucks	28,312	32,216	13.8
Cream separators	30,608	N.A.	N.A.

The number of milking machines decreased 24 percent in the decade, while milk output rose 18 percent from 1.1 billion to 1.3 billion gallons. Since the number of workers on dairy farms did not increase (and most probably decreased--see p. 31), milking machine efficiency, and perhaps capacity, must have increased considerably. The decline in cream separators is a result of increased tanker collection of milk, which had its impact mainly in the 1950's but continued to effect changes in dairy industry structure in the 1960's.

Tanker collection of milk.--In 1959/60, most dairy farmers were supplying cream instead of whole milk to dairy factories and using the skim milk for pig rearing.

As prices for skim milk products rose, the relative profitability of pork production declined and farmers began to supply milk to dairy factories. Also, the "increasing use of herringbone sheds encouraged many farmers to change from cream to milk supply and specialize in dairy production, ridding themselves of the pig units (174, 1972)." The efficient collection of whole milk was made possible by the use of tankers instead of cans. Tanker collection has resulted in less time spent by farmers taking milk or cream to the factory, and enabled consolidation of factories into larger units with additional benefits to the supplier (51). In 1964/65, tankers collected 86 percent of the milk delivered to dairy factories and in 1969/70, 95 percent. About 85 percent of the suppliers delivered whole milk to dairy factories in 1971/72, compared with only 33 percent in 1959/60. Butterfat received as wholemilk by factories increased from 52 to 93 percent of total butterfat processed (174, 1966, 1971-72).

Herringbone milking systems.--The average New Zealand dairy farmer spends about 3 hours a day milking and another hour preparing for, and cleaning up after, milking (43). Innovations in milking shed design and milking techniques have allowed significant increases in output per labor unit. The introduction of the herringbone (HB) milking system in the 1950's was probably the major step enabling dairy farmers to milk more cows and carry larger herds without hiring additional labor. In contrast to the traditional walk-through milking shed in which cows stood parallel in individual "bails" or stanchions and the milker had to bend at intervals, the HB system enables a man to stand up straight (because of a pit between two herringbone-design rows of cows). Cows can be milked in batches, and the amount of walking is reduced. One estimate is that the HB system increased the milking rate from about 45 to 60 cows per man-hour (51, 1971). A 1962/63 survey showed that the number of cows per man on farms where HB systems were used was 23 percent greater (HB 64, walk-through, 52); milk production per cow was 3 percent less; but production per milker was 20 percent higher. For the 83 farms in the survey for which information was available, cow numbers increased by 600 but labor requirements declined by 5 men (43).

Bigger dairy herds were made possible by the HB design (27). In a 1969/70 survey (about 10,600 farms including both town-milk and factory suppliers), average herd size was 88 cows for farms using the walk-through design and 129 cows for farms using the HB. Milkers in HB systems milked an average of 73 cows and those in walk-through sheds, 54 cows (175, 1969/70, p. 32).

An estimated 36 percent of New Zealand's dairy farmers were using HB milking systems in 1968/69. On farms where artificial insemination was used, adoption of the HB system was especially rapid, with about 50 percent of such farms using the HB system in 1967, compared with 10 percent in 1963 (175, 1967/68-1969/70). Users of artificial insemination, as indicated earlier, carry larger herds than average.

Rotary milking systems.--Diseconomies of scale from relatively large HB-design milking sheds that accommodate large herds have led to an interest in rotary-design milking systems. (Size of herds is discussed in the "Economies of Size" section.) Types of rotary-design sheds vary, but in essence they comprise a revolving platform or "turnstill" on which cows are put. The most important advantage is they they can improve milking efficiency even at high "throughputs" by eliminating time-consuming operations such as movement of milkers between cows. The rotary system is very adaptable to automation of certain milking functions. Devices such as automatic teat washers, premilking stimulators, and mechanisms for automatic removal of milking machine cups are currently being tested in an effort to further reduce labor requirements. These advantages could lead to one-man units capable of milking about 100 cows an hour. The rate of productivity being worked on is suggested by claims that "a one-man unit will probably expand to about 150 cows in the foreseeable future," and "for larger farms, rotary milking systems will allow two or three men to milk herds of 300 to 500 cows with relative ease (223).

Various types of rotary-design milking systems are presently available at different costs and designed for maximum efficiency at different herd sizes, but a great deal of development and testing is in process. At the Ruakura Agricultural Research Center, a one-man "turnstile" with automatic teat-cup removal units is permitting 80 to 90 cows to be milked per hours. The New Zealand Department of Agriculture is testing a double turnstile system that requires three operators and gives a throughput of 200 to 240 cows per hour or two men with a throughout of 160 to 180 cows per hours.

Artificial Insemination

Commercial artificial insemination (AB) of cattle, introduced in New Zealand in 1950, has expanded rapidly. 13/ In 1969, slightly more than 1 million cows were inseminated artificially, compared with 496,000 in 1960. It is generally recognized that superior breeds of sires should be used for genetic improvement and that AB provides an efficient tool toward this end. "By far the greater part of the increased (livestock) production has resulted not from any reduction in animal diseases but from improvements in the genetic quality of the animals and from the improvement in general farming techniques (262)." Genetic improvement has been advanced mainly through the Dairy Board Herd Improvement Program, which includes Herd Performance Recording, Sire Survey, and AB. There has been vast improvement in reducing the amount of sperm required per insemination, permitting wider coverage per bull and greater use of proven bulls and those with highest ratings (175).

Year	Cows artificially inseminated	Percent of all dairy cows
	Thousands	Percent
1955	156,000	8
1960	496,000	26
1965	768,000	37
1969	1,026,000	43

Source: (175, 1969/70).

AB has been used almost exclusively for dairy cows. Artificial insemination in the beef herd is relatively new in New Zealand and the major effects will occur in the 1970's. The extent of AB use in beef cattle is not known accurately--only a few "tens of thousands of cows" out of about 1.8 million beef cows and heifers of breeding age (44, 1971). Factors that have inhibited a faster growth of AB in beef cattle are: (1) Restrictive rules of pedigree breed associations; (2) the fact that progeny testing is almost unknown in New Zealand and therefore there is a lack of known superior sires; and (3) practical difficulties--beef cows, in contrast to dairy cows, are spread out over large areas, are unused to individual handling, and consequently greater effort is needed to detect estrus (44).

Holstein-Friesian Cattle

Another major factor affecting beef and dairy production is the accelerating

13/ In New Zealand, artificial insemination is termed artificial breeding or AB.

adoption of the Holstein-Friesian breed of cattle. 14/ These cattle, efficient in producing either milk or beef, are in effect restructuring the dairy industry.

The trend toward the Holstein-Friesian was evident even in the 1950's, but the increase in the number of these cattle did not become significant until the late 1960's. Briefly, the breed has the following advantages: It offers the dairy industry flexibility in terms of milk/beef production tradeoffs. Although the butterfat content of its milk is not as high as that of the traditional and numerically dominant Jersey breed, its milk output is higher (51). As a beef animal, the Holstein-Friesian grows faster than traditional beef breeds (Angus, Hereford, Shorthorn), and its carcass has a lower fat content at "killable weights." With butter and cheese prices declining in the late 1960's, more profitable markets for casein and skim milk powder, and increased demand for beef, the economic advantage of using Holstein-Friesians became generally evident. Growth of the dairy/beef industry is to a large extent a function of adoption of the Holstein-Friesian breed of dairy cattle.

Between 1963 and 1971, Holstein-Friesians as a percentage of the total dairy herd increased from 11.5 to 22 percent (174, 1971, 1972):

Breed	Percent of national dairy herd	
	1963	1971/72
	Percent	
Jersey	81.0	74
Holstein-Friesian	11.5	22
Ayrshire	4.9	3
Milking Shorthorn	2.6	1

Data indicate that the swing to Holstein-Friesians will continue. Artificial inseminations from the Holstein-Friesian breed increased from 16 percent in 1961 to 56 percent in 1971, while for Jerseys, the percentage dropped from 77 to 38 percent (174, 1972). By 1973/74, the percentage of Holstein-Friesian and Holstein-Friesian cross-bred animals in the dairy industry will increase to the level where "50 percent of two-year-old heifers coming into milk will be 50 percent or more Friesian blood." (51)." Evidently, a great deal of crossing and building up to the Holstein-Friesian is taking place. On sheep farms, also, increasing numbers of Holstein-Friesian and Holstein-Friesian cross-bred steers are being carried for slaughter at about 20 months of age to give carcasses weighing about 500 pounds. Sheep farmers are buying Holstein-Friesian weaners as well as mating their beef cows to Holstein-Friesian bulls and retaining the heifer calves for future breeding (14).

Economies of Size

The size of dairy herds increased markedly in New Zealand in the 1960's. Average herd size rose from 57 cows in 1959/60 to 98 in 1969/70 and 103 in 1971/72.

14/ The Holstein-Friesian breed of dairy cattle originated in the Holstein and Friesian provinces of the Netherlands. "Holstein" and "Friesian" are synonymous terms. The U.S. uses "Holstein" while New Zealand prefers "Friesian." Hereafter, in this report, "Holstein-Friesian" will be used.

Herds of 80 or more cattle accounted for 63 percent of the total number of all herds in 1969/70, compared with only 22 percent in 1961 (175; 174, 1971/72). 15/

The average sheep flock also increased in size. In 1970, 56 percent of the flocks were of the 1,000-or-higher size, compared with 45 percent in 1961 (191, 1969/70). Although economies of size could be expected from larger farm operations, factors such as uncertainty, managerial ability, and tax structure are also important in determining whether to increase size of farming operations (77).

Economies of size (as distinct from all other factors promoting efficiency) are difficult to measure. The term itself is not easy to define and there is no single measure which gives an unequivocal measure of farm size. A study (219) attempting to measure economies of size (defined in the study in terms of herd size--which is not necessarily synonymous with large farms or with high stocking rates) showed that the cost of producing a pound of butterfat (or milk) actually increased slightly as herd size increased. Economies of size appeared to operate for all expenditures except labor, and there the diseconomies outwieghed all other economies. However, the labor diseconomies were found to be a function of the rapidity of herd size expansion (which posed adjustment problems for management). Over time, as management adjusted to the larger operations, it was anticipated that full economies of size would operate (219).

Another study (107, 1971) reviewed the technical and primary economies associated with greater size: specialization of labor; the spreading of "overhead" labor costs "over a greater number of cows and therefore units of output;" technical or engineering efficiencies associated with size (for example, length of fencing required per acre declines as farms of a given shape are increased); and economies associated with purchasing and selling in bulk. At the same time, diseconomies can occur from disease problems when large numbers of livestock are run together, and from managerial problems when the number of decisions to be made increases with size of operations. With respect to fencing, the investment cost on a per cow basis declined from $58 for 60-cow farms to about $18 for 600-cow farms; administrative costs also declined from $3.20 to $0.50 per cow; and repairs and maintenance expenses per cow decreased. The study found that the highest per cow profits were earned by the largest farm (5-man/600-cow farm), but the difference between the five farm-size groups in the study, in terms of maximum profits per cow earned, was not great. ("Maximum" was defined as the highest profits earned by the largest units on each farm-size group). This is shown below:

Size of farm	Profit per cow
	N. Z. dollars
1-man	13.15
2-man	14.50
3-man	15.23
4-man	16.24
5-man	17.46

Table 13 provides an indication of economies of dairy farm size for 1968/69. Data, which are from a New Zealand Dairy Board survey, cover factory-supply farms. As farm size--whether measured in acreage or average size of herd--increases, the per acre income and expenses decrease but net farm income increases up to a farm size of about 222 acres (201 to 250 acres farm-size group). With larger farms, diseconomies would appear to prevail.

15/ Herds of 10 or more cows and including both factory-supply and town-supply herds.

Table 13--Income and expenditures, by size of dairy farm, New Zealand, 1968/69

Item	Unit	Up to 50 acres	51 to 100 acres	101 to 150 acres	151 to 200 acres	201 to 250 acres	251 or more	All farms
Farms	Number	27	480	600	312	158	150	1,727
Herd size	do.	46	76	103	123	137	132	104
Butterfat per farm	Pounds	13,690	22,500	29,590	34,140	38,580	34,610	29,450
Milk per farm 1/	do.	291,300	478,720	629,570	726,380	820,850	736,380	626,600
Butterfat per acre	do.	308	275	236	198	174	91	194
Milk per acre 1/	do.	6,550	5,850	5,020	4,210	3,700	1,940	4,130
Gross farm income per acre	Dollars	124.43	109.65	92.48	78.73	69.70	38.37	77.49
Farm expenses per acre	do.	76.89	66.39	59.46	52.47	48.10	27.84	50.71
Net farm income per acre	do.	47.54	43.26	33.02	26.26	21.60	10.43	26.78
Net income per farm	do.	2,092	3,547	4,194	4,543	4,795	3,984	4,071

1/ Based on 4.7 percent butterfat-in-milk content.
Source: (177, 1968/69).

Better Pasture Management

Pasture management in New Zealand is aimed at maximizing pasture production (subject to cost) and optimal balance between patterns of pasture growth and livestock intake requirements. In dairy farms, particularly, the "fit" between pasture supply and dairy cattle requirements is critical because of increasingly higher stocking rates. The following features characterize the system of pasture grazing: (1) Use of artificial fertilizers (especially phosphatic and potassic) to correct soil nutrient deficiencies; (2) high stocking rates to fully utilize pasture availability; (3) controlled grazing to permit intake variations according to varying requirements over the year; (4) conservation of surplus pasture growth, either as hay and silage or saved pasture, for feeding during periods of limited pasture growth such as during winter, or when feed requirements are high such as during the early part of the lactation period (248).

High Stocking Rates

Perhaps the most important technological contribution to New Zealand livestock production in the 1960's was the general acceptance of higher stocking rates--often cited as the key to greater farm profitability. On hill country farms, in particular, high stocking rates raised overall productivity and moderated the impact of lower wool prices (27).

The optimum stocking rate varies from farm to farm, but the consensus appears to be that stocking rates could be substantially increased in New Zealand before net diseconomies set in. An implicit endorsement of this is the increase in livestock units (ewe equivalents) projected by the Agricultural Development Conference, based on carrying capacities per acre for different regions in New Zealand (179). It was estimated that in the mid-1960's, average utilization of pasture probably did not exceed 40 percent and could have been as low as 30 percent (238).

Tests at the Ruakura Agricultural Research Centre show that while average live-weight at slaughter and average carcass weight decreases with higher stocking, production of meat per acre increases (table 14). More than 450 pounds of boned-out meat per acre were obtained at stocking rates of 2 to 2.5 cattle per acre, although supplementary feed was needed for trials with the highest stocking rates. The net meat production figures are very high because young, low-weight animals which grow rapidly were brought in and carried through one winter only (223, 1969).

Dairy farm trials at Ruakura and elsewhere demonstrate that with high stocking rates (1.5 to 2 cows per acre), an average production of 450 to 550 pounds of butter-fat per acre (9,575 to 11,700 pounds of milk), can be achieved by using farm-growth herbage as the sole feedstuff. Highly developed skills of pasture and herd management are required, however (23). In one study (106), net income was shown to increase as the number of cows per 100 acres increased, up to a maximum of 160 cows:

Cows per 100 acres	Gross income	Total expenses	Net income
		1,000 N.Z. dollars	
100	14.6	8.3	6.4
110	16.5	9.1	7.3
120	17.4	9.5	7.9
130	18.6	9.7	8.8
140	19.5	10.0	9.5
150	20.0	10.3	9.8
160	20.3	10.5	9.8

Table 14--Effects of higher stocking rates on beef production, New Zealand, 1967-69

Item 1/	Unit	Cattle per acre					
		1.5		2.0		2.5	
		1967/68	1968/69	1967/68	1968/69	1967/68	1968/69
Mean weight at slaughter	Pounds	808	874	774	753	737	689
Mean carcass weight	"	418	467	394	405	364	376
Percentage GAQ & FAQ 2/	Percent	64	86	28	61	37	91
Carcass meat per acre:							
Gross	Pounds	642	726	782	809	890	919
Net (gross minus calf carcass weight)	"	529	584	632	628	700	698
Boned-out meat per acre:							
Gross	"	469	547	566	602	648	674
Net	"	390	448	461	475	515	519

1/ The items relate to a system in which dairy/beef weaners 8-10 weeks of age, weighing 150-200 pounds liveweight, were purchased in, fattened, and slaughtered at 18-20 months just before the second winter. "The use of these smaller (dairy/beef) weaners with their very much lower maintenance requirements...increases the potential outputs of beef per acre [from] 400 pounds to 500 pounds per acre [to] 550 pounds to 600...(110, 1969)."

2/ Good average quality; fair average quality.

Source: (110, 233).

For factory-supply dairy farms (with 30 or more cows per herd), stocking rates increased steadily during 1964/65-1968/69, from 57 to 68 cows per 100 acres (177, 1968/69). The greater the herd size, the higher the stocking rate per farm. On a regional basis, however, stocking rates are more a function of climate, soils, and topography (app. table 23).

Some problems posed by high stocking rates are: (1) The greater chance of animal illness; (2) a greater strain on the labor supply, much of which is presently family labor, as more replacement calves have to be raised and winter feeding becomes more extensive; and (3) greater vulnerability to losses in the event of adverse weather (27).

The trend to higher stocking rates is likely to continue. Techniques that could help bring this about are:

(1) The use of nitrogenous fertilizers to increase late-winter and early-spring grass growth. (One evaluation, however, is that pasture response to nitrogenous fertilizers is not completely assured in terms of volume, and that the effect of heavy applications on stock health is still uncertain. See 23).

(2) Irrigation. "More than any other input, (this) has the potential to increase substantially annual dry matter (D.M.) production from pasture. The magnitude of increase averages about 30 percent or 3,800 pounds of D.M. per acre at a cost of 1¢ per pound of D.M." (23).

(3) In areas with poor-draining soils, the use of wintering pads and barns, where cows can be fed on hay or silage, thus preventing pasture damage

in periods of wet weather (248).

(4) "Late" calving. Delaying the calving date 5 weeks later than usual has been shown to give a better "fit" between pasture supply and feed need patterns (97 and p. 44).

(5) Greater reliance on stored feed and yard feeding (see next section, "Use of Concentrates").

(6) The use of feed concentrates during the early part of the lactation period if pasture is in short supply. (The routine use of sizable quantities of concentrates is generally not profitable in New Zealand. See below.)

(7) The cultivation of crops such as maize to shift the period of fodder conservation away from the time of peak pasture growth, when cattle requirements are also highest. Maize silage would be a suitable supplement for grazing, lactating cows.

An optimal situation has been expressed as a 100-acre farm carrying 190 cows (a stocking rate of almost 2 cows per acre) and growing maize for silage at 300 tons on 15 acres at a cost of 1.5 cents per pound of dry matter (23). In good pasture areas such as the Waikato (South Auckland), it is possible to attain an "almost unrestricted level of winter feeding" at a stocking rate of 1 to 1 1/4 cows per acre. The standard recommendation (in this area) for silage or hay conservation (for winter) is about 1/3 acre per cow, yielding 18 to 20 bales of hay (or its silage equivalent) (30).

Potential for Use of Concentrates

Using feed concentrates such as barley or maize meal permits higher stocking rates than possible with pasture grazing alone. The economics of this are highly variable but, in general, it appears that concentrates could be profitably used only as supplementary feed during periods of grass shortage.

One analysis contends that given the 1971 price structure, there is no place for feedlot beef raising in competition with all-grass beef fattening, but that some potential for concentrates exists in dairying (3). Recent experimental work on beef production indicates that limited use of concentrates could be profitable as a means of increasing yearling cattle growth rates during late summer prior to slaughter (112, 1970). Eighteen-month old Holstein-Friesian steers averaging 788 pounds were fed fresh-cut pasture for 12 weeks, then pasture hay for 7 weeks, at different levels of maize meal feeding (0.25%, 0.50%, 0.75%, and 1.0% of steer liveweight per day). Allowance for the greater digestability of maize meal was made by lowering the normal cost of meal per pound of carcass weight gain from 50 cents to an "effective cost" of 38 cents. Costs and returns showed that at a low level of meal feeding (0.25%-0.50%), returns would exceed those from a pure pasture system: A higher dressing-out percentage (liveweight-to-carcass weight) and higher prices for meal-fed carcasses were assumed; without this "lift," meal feeding would show a loss. It should be emphasized that the profitability applies only to feeding practices during a limited period--late summer. Further, "for cattle of the traditional early-maturing breeds, top-priced carcass grading is relatively easy to achieve off pasture, and this could limit the role of meal feeding for these beasts."

In dairying, experiments on high stocking and "late calving" indicate that supplementary feeding with concentrates could be profitable (97, 1968; 96, 100, 98,

Item	Unit	Level of maize feeding: Percent of liveweight				
		0	0.25%	0.50%	0.75%	1.00%
Carcass weight	Pounds		465	510	512	465
Returns:						
Per 100 lbs. carcass weight	N.Z. dollars	17.5	24.1	24.1	24.2	24.1
Per carcass	"	23.5	112	123	124	123
Added value per carcass	"	10.85	23.57	30.92	33.62	34.62
Meal costs at 3 cents a lb.	"	0	8.31	17.64	25.66	33.71
Surplus over meal costs	"	10.85	15.26	13.28	7.96	0.91

1971). 16/ At two cows per acre and with late calving, an output of 617 pounds of butterfat per acre (13,130 pounds of milk) was achieved on the average for three seasons during 1965/66-1967/68. Twenty bales of hay and 1/2-ton concentrates per acre per year were required in addition to grass and hay or silage grown on the farm--an estimated increase of 10 to 15 percent over farm-grown feed. Average butterfat output was one-third more than that obtained on a lower stocked but self-contained farm with a stocking rate of 1-1/2 to 1-2/3 cows per acre (1-1/2 cows per acre is about the minimum stocking possible on all-grass system in the Ruakura (South Auckland) area, without depressing per acre output). Profitability increased per acre, assuming prices of 35 cents per pound for butterfat (equivalent to 1.65 cents per pound of milk), concentrates at $65 per ton (3 cents per pound), and hay purchased at $22.50 per ton (1 cent per pound). For conventional "early" calving, profitability was about even with the all-grass system. If high-moisture-containing barley can be stored and handled on the farm for stock feeding at about 2 cents per pound (estimated feasible), the profit margins per acre would approximately double for the late calving system.

An important qualification to the dairy results, however, is that "except at very high capacities where production per acre and managerial skill are also high, meal feeding will, in general, be less profitable than alternatives which will allow more grass to be grown or made available at critical times (96)." Thus, greater attention must be given to increasing total grass production and minimizing fluctuations in plant growth. 17/ For example, at an estimated cost of less than 1 cent per pound, extra-pasture dry matter produced by irrigation is more competitive than other feedstuffs used to support production in dry spring and summer periods. Also, conservation of farm-grown feeds could be improved. For example, investigations are in process to examine the contribution of maize and other crops which are capable of substantially higher yields than grass or clovers during the summer months, which require only limited areas, and which can be conserved during autumn instead of spring. These practices could help raise butterfat output per acre an extra 200 pounds (equivalent to 4,255 pounds of milk)--considered a realistic goal (97). (This would mean a target production of 900 pounds of butterfat--or about

16/ "Late" calving in August-September rather than 5 weeks earlier (which is conventional) allows a more flexible system of wintering. As grass growth increases in August-September, cows can be brought to calving on a rising plane of nutrition much more readily than a month earlier, and this is important at high stocking rates. Late calving cows reach a higher initial peak milk yield and maintain this advantage throughout a slightly short lactation (97).

17/ 15,000 to 20,000 pounds of dry matter per acre have been reported from plot scale trials (100).

19,150 pounds of milk--per acre, given extremely high-producing pastures, stock of exceptionally high genetic merit, and complete utilization of all feed grown.)

An independent estimate of the potential for use of concentrates in New Zealand has been made. The results, in Appendix E, are not conclusive but suggest that the milk/feed grain price ratio in New Zealand is about 0.50, compared with a range of 1.6 to 1.95 for the United States and 1.1 for the Netherlands. This means that either New Zealand's milk price must more than double or the cost of its feed grain imports must fall by more than one-half for New Zealand to be near the dairy situation of countries relying on concentrates as a major feed.

The following assessment, in conclusion, appears applicable:

> "...in general, until farmers have raised the overall productivity of their pastures through improved topdressing and management, and have increased carrying capacities and per acre productions to levels which will ensure a low pasture dry-matter loss in the field, and have reduced hay and silage loss to an effective minimum, the use of expensive feedstuffs like concentrates for future increasing production should not be considered. Under conditions such as at Ruakura these levels will be at least 1.5 cows and 450 pounds of butterfat per gross acre or their equivalents...Under certain circumstances caused by mismanagement, a particularly bad season, or in 'wet' dairying areas (with poor soil drainage), meal feeding can be used effectively...(but) this must be considered a stop-gap procedure to minimize loss, not to maximize returns (100)."

An indication of the trend toward greater reliance on hay and silage is the approximately 40-percent increase that occurred during 1961-70 in acreage devoted to grasses, clovers, and lucerne cut for hay and silage (table 15).

Table 15--Area in supplementary fodder crops in New Zealand, selected years

Crop	1960/61	1964/65	1969/70
		1,000 acres	
Grasses, clovers, and lucerne cut for hay or silage	994.3	1,201.0	1/ 1,405.5
Cereal crops	75.5	90.5	2/ 114.5
Rape, kale, other green fodder crops	288.0	251.0	185.3
Root crops	448.5	483.9	3/ 374.0
Total area of fodder crops 4/	1,806.3	2,026.4	2,079.2

1/ Of which grasses and clovers account for 1,214,500 acres.
2/ Of which oats account for 70,400 acres; wheat, 18,000 acres, barley, 17,900 acres; and maize, 8,100 acres.
3/ Excludes turnips and other crops equal to 26,400 acres in 1968/69.
4/ Excludes small areas of other minor fodder crops.

Source: (187).

Research and Diffusion of Technology

Livestock production research in New Zealand is conducted mainly by the New Zealand Department of Agriculture (NZDA) and the Department of Scientific and Industrial Research, but important specialized work is conducted also by universities and

independent organizations. Research investment in agriculture increased from $5.7 million (excluding funds for buildings) in 1964/65 to $13.1 million in 1970/71 (187, 1967, 1972).

The diffusion of production technology has been rapid since the Agricultural Development Conference (ADC) in 1963/64 (see chap. V). Communication of technical expertise has been improved by the establishment of District Agricultural Advisory Committees that coordinate all organizations servicing agriculture in each region of the country and by the creation of about 700 farmer discussion groups. Two major sources of institutional advice, the farm advisory officers of the NZDA and consulting officers of the Dairy Board, participate in the discussion groups. Farmer conferences, held annually at the major agricultural research stations (Ruakura in the North Island and Invermay in the South Island), at the agricultural universities (Lincoln and Massey), and in some farming districts serve to introduce ideas and methods, with followup by small, local groups. In 1963, the Agricultural Engineering Institute was established (financed by the NZDA) for testing, research, and promotion of agricultural engineering technology.

At ADC initiative, "beef committees," such as the South Auckland Beef Development Committee (243), were formed. By providing farmers with practical advice on beef cattle production and marketing, the committees have proved to be a major stimulus to the development of the dairy/beef industry and beef production in general.

Contract services have been expanding. Some member advisers to Farm Improvement Clubs (started in the 1950's to provide technical, financial, and management advice and supervision to members) have set up private practice and now contract out their services to their former club or to individual farmers. Lincoln College has a self-supporting farm management consulting service. Also, there is a trend toward contract service for agricultural equipment, especially for harvesting and farm maintenance. New, highly specialized farm equipment, which would be uneconomic for farmers to own individually, is now being made available on a contract basis.

A new source of commercial expertise is provided by beef production promotion syndicates established in the 1960's. These draw investment funds from urban as well as rural sources, provide calves to be reared by farmers on contract, handle marketing, and provide technical advice to participating farmers (78).

V. GOVERNMENT POLICY

Government policies for livestock development in New Zealand are extensive, affecting production, pricing, and marketing. In this chapter, various production incentives are outlined. Most of these are designed to improve productivity and reduce the cost and expand the availability of necessary inputs. Government pricing and marketing policies are discussed in chapter VI. Policies on export marketing, largely aimed at diversification and promotion, are covered in chapter VIII.

Results of the 1963/64 Agricultural Development Conference (ADC) dominated farm policy in New Zealand during the rest of the 1960's. Long-run growth targets for agriculture were established, and several important policies to implement the targets were drawn up and subsequently enacted.

Agricultural Development Conference

The ADC set a livestock target of 111 million ewe equivalents for 1972/73, based on f.o.b. prices of 35 cents per pound for greasy wool, $300 per ton for meat, and the existing prices for dairy products. This target was reaffirmed at the 1969 National Development Conference, in which agriculture was fitted into a targeted overall growth pattern for the economy, and in which a goal of 130 million ewe equivalents was set for 1978/79. Major policies to support the agricultural expansion program related to tax incentives, input subsidies, and provision of investment funds.

Tax Incentives

Livestock Incentive Scheme

The livestock incentive scheme, incorporated in the Land and Income Tax Amendment Act of 1966, was designed to assist in fulfilling the targets for increased livestock numbers. Tax payment on the increased capital value of livestock additions was deferred above a base period until the stock was sold (238).

Farm Income Equalization Scheme

Recommended by the ADC and effective starting in 1964, this scheme was designed to help farmers carry out a planned development program by offering a degree of protection from fluctuations in income. A farmer could deposit up to 25 percent of his annual assessable farm income in a special tax-free account. In a year of lower income, the money could be withdrawn and used for continued farm development. This could have been particularly advantageous if a farmer worked out his farm operations to ensure that withdrawals from his special account were spent on deductible items such as repairs, maintenance, or development. But the scheme was not widely used, apparently because no interest was paid on the deposited funds, and other measures of equalizing income were used (185, 246).

Accelerated Depreciation

To accelerate writeoffs of assets and thereby reduce tax in the years immediately following purchases, the ADC recommended a "special depreciation" rate as an incentive to modernizing buildings and equipment. This rate, which supplemented ordinary depreciation rates for tax purposes, was subsequently extended to cover all farm buildings (homesteads excepted).

Development Allowance

Expenditure on the development of new land, marginal land, or existing farms could be deducted from income and deferred from tax liability for 9 years. The deferment thus served to offset taxes on future increased income resulting from the development project Deductible items covered expenditures for projects such as landing strips (for aerial topdressing); initial clearing of land; irrigation; erosion prevention; new fencing; erection of power and telephone lines; cost of bulk storage bins for fertilizer; and construction of access roads and bridges (185).

Input Subsidies and Grants

Fertilizer Subsidies

In 1965, following ADC recommendation, a subsidy for the transport of fertilizer (excluding lime) was introduced to encourage development of remote hill country. The fertilizer transport subsidy, last increased in June 1971, amounts to 7 cents a ton for each mile between 20 and 100 miles, and 4 cents a ton-mile over 100 miles. For distance up to 20 miles, the rate remained at 9 cents a ton-mile. Subsidy payments rose from $2.5 million in 1966/67 to $7.0 million in 1970/71. The subsidy for transport of lime for application to newly developed land was also increased--it is 6 cents a ton-mile up to 60 miles and 2 cents a ton-mile thereafter. The total cost in 1970/71 was $128,000. A fertilizer price subsidy of $5 per ton from the factory, effective beginning July 1970 was increased to $7.50 in June 1971. The subsidy amounted to $5.4 million in 1970/71 (187, 1972).

Emergency Relief

Drought relief to assist farmers running short of stock feed normally amounts to less than $400,000 a year in New Zealand. But in 1970/71, when drought was particularly extensive, emergency relief reached an unprecedented $3.5 million. A special Agricultural Assistance Fund of $10 million for short-term, interest-free loans of up to $3,000 was established to assist farmers who encountered serious financial difficulties for reasons beyond their control (187, 1971; 234, July 1970; 193, Dec. 1971).

Stock Retention Incentive Scheme

To help preserve the production capacity of the sheep industry, which was under severe financial strain in 1970/71, the Government established incentive payments for retention of sheep owned on June 30, 1972. Payments amounted to $1 per sheep for farmers owning flocks of 251 to 5,000 sheep. Smaller payments were made for larger flock sizes. The total cost to the Government for this one-time measure was $34-$35 million (183; 193, Dec. 1971). An additional $15 million was contributed from the Meat Industry Reserve Account (194, 1972).

Dairy/Beef Diversification Scheme

A 1965 working party, set up by the Agricultural Production Council, recommended that a large-scale dairy/beef industry be promoted in New Zealand. "Beef (development) committees" were formed in districts where beef production, especially production from dairy-bred animals, could be stimulated. A scheme was established to encourage dairy farmers to retain, for beef production, surplus calves that would otherwise be slaughtered as bobbies. Effective in 1969/70, this scheme was aimed at preserving the productive capacity of the dairy industry at a time when short-run prospects for milk products, especially butter, were poor. Another objective was to increase beef production to take

advantage of increasing world demand. A $10 payment was made for each calf wintered on a dairy farm. In addition, dairy farmers were given advances at a concessional interest rate to cover temporary loss of income when switching to beef production. This diversion payment was often the most important factor determining whether a dairy farmer engaged in dairy/beef enterprise. By early 1970, some 160,000 head of dairy/beef cattle had been registered by 3,500 dairy farmers (14). The Government's diversion payments in 1970/71 amounted to about $1.1 million (187, 1972).

With dairy prices improving in 1971, the diversion payments were not continued beyond September of that year. Earlier, the scheme had been criticized, by some, as slowing down the trend toward larger and more efficient dairy farms; that by stimulating beef production, which requires less labor than dairy production, the scheme was blunting the desired structural adjustment toward larger milking herds and labor economies associated with larger operations (265).

Other Subsidies and Grants

Subsidies for "weedicide and pesticide" were introduced in 1969, and payments to farmers reached $4 million in 1970/71. These subsidies were provided to help meet the cost of more expensive materials required because of restrictions on such substances as DDT. The subsidy was terminated in June 1973. Other major subsidies and grants are shown in appendix table 24.

Investment

State Advances Corporation Farm Loans

The ADC succeeded in obtaining assurance that the State Advances Corporation and the Marginal Lands Board--principal lenders of farm development funds--would provide sufficient funds to meet an anticipated increase in demand for development finance. The two institutions provide loans to farmers who have worthwhile development projects but who cannot obtain sufficient private finance. Farm loan authorizations by the Corporation increased from $11.6 million in 1960 to $53.3 million in 1970/71 (187):

Fiscal year	Farm loan authorizations
	Million dollars
1960	11.6
1965	41.8
1966	40.1
1967	44.3
1968	23.7
1969	28.0
1970	47.9
1971	53.3

The Corporation provides loans for several purposes in addition to development of farmland (clearing, grassing, topdressing, for instance). Loans are provided for initial purchase of farms and livestock and construction of buildings. Also, loans are made to amalgamate uneconomic and fragmented land areas, and thus to strengthen existing units and reduce the number of uneconomic units. In its 1970 budget, the Government increased by $5 million the sums available to the Corporation and the Marginal Lands Board for restructuring farming by amalgamation into more efficient

large-scale units (234, July 1970). The Corporation also provides loans to assist in stock retention on land to refinance certain debts.

A farm mortgage guarantee scheme, first applied to the sheep industry because of the drastic fall in wool prices in the late 1960's, is operated by the Corporation. Th scheme, which was later extended to the dairy sector, is designed to draw more funds from the private sector into farming. The Corporation guarantees the lender prompt pay ment of loan obligations (187; 234, June 1971; 186).

Marginal Lands Act

The Marginal Lands Act of 1950 provides funds for developing marginal farmland. During 1950-70, loans financed under the act permitted development of 214,000 acres of grassed area, with an increase in carrying capacity estimated at 513,000 sheep, 22,000 beef cattle, and 22,000 dairy cows. In 1971, the value of loans was $3.4 million, compared with $567,000 in 1960 and the record $4.9 million in fiscal year 1966 (187).

The pattern of marginal lands lending changed markedly during 1967-71. Land devel(ment, previously the main item of expenditure, dropped from over 50 percent of total spending in 1967 to less than 30 percent in 1971, and indications are that it will drop further. On the other hand, demand for finance for purchase of additional land to strengthen marginal properties increased markedly, and such demand will probably continue to rise (186).

Land Development

Government land development in New Zealand began on unimproved land owned by the Crown during the depression of the early 1930's, largely as a means of providing employment. Current policy emphasizes development costs relative to the profitability of the subsequent farming operation. The Department of Lands and Survey (and the Department of Maori and Island Affairs) clears the land and then farms it until the new pasture is well-established and soil fertility has built up. The land is then offered for sale to qualified applicants. As of March 31, 1971, the Department of Lands and Survey had 1.2 million acres of land under development for settlement--about 60 percent was in the North Island. Large tracts are in South Auckland, Northland and Southland. In addition to land for eventual settlement, the Department also has under development 450,000 acres of high country at Molesworth Station, South Island, which has just started to be profitable, and 160,000 acres being farmed and developed for other Government units (186).

Large numbers of cattle and sheep are used to trample fern and scrub and consolidat pastures in land development areas. Sales of livestock finance part of development costs (186):

Year ended June 30	Unit	1966	1967	1968	1969	1970
Beef cattle sold:						
Number	Thousands	39	40	41	66	83
Receipts	Mil. dol.	3.2	3.0	3.3	5.1	7.0
Sheep sold:						
Number	Thousands	518	577	606	868	945
Receipts	Mil. dol.	3.0	2.6	2.5	3.9	4.7
Wool Produced:						
Volume	Mil. lbs.	13.8	14.7	16.2	17.0	18.9
Value	Mil. dol.	4.1	3.6	3.2	4.0	4.1

In 1970, 1.9 million sheep, 222,000 beef cattle, and 4,400 dairy cattle were under Lands and Survey management. An additional 625,211 dairy cattle were managed by the Department of Maori Affairs and the New Zealand Department of Agriculture (186, and estimated by N. Taylor, New Zealand Meat and Wool Boards' Economic Service, Mar. 1972). Large-scale breeding projects are being undertaken to improve sheep lambing percentages and to increase beef production. Major trials are being conducted in the Rotorua (South Auckland) and Northland development districts to identify genetically superior animals. Charolais semen is used on Friesian Cows for Charolais cross dairy/beef breeds. Santa Gertrudis cattle have recently been imported to produce hardier cattle more suitable for Northland (186).

Wage Controls

The increasing scarcity of farm labor could limit potential livestock development in New Zealand. Sociological factors and higher wages outside agriculture have been drawing labor out of farms. In addition, in recent years, a wage-price spiral has developed, resulting from a breakdown in traditional arbitration procedures. In 1970, wages were estimated to have increased an average of 15 percent, and in March 1971 the Stabilization of Remuneration Act was passed with the general aim of limiting annual wage settlements (187, 1971; 234, June 1971).

* * * * *

Not all official measures to promote livestock development in New Zealand have been fully utilized. The agricultural development programs have not been compulsory, and adverse market conditions have often dominated investment decisions, such as in 1967-69, when the market outlook for wool, butter, and cheese seemed especially dim (246). The influence of Government policy, however, extends beyond merely the various measures enacted to facilitate beef, dairy, and other pastoral industry growth. As highlighted by the ADC, Government policy in the 1960's inculcated a sense of national farming purpose and strengthened communication among producers, marketers, and Government. Livestock industries will be beneficially shaped by this legacy in the 1970's.

VI. MARKETING INSTITUTIONS AND PRICING POLICIES

This chapter outlines the channels through which New Zealand livestock and livestock products move to different market outlets, and the institutions and public policies influencing prices.

Marketing livestock products for export (the major market) is subject to statutory regulations. These have evolved from legislation in the 1920's designed to give farmers better control over the marketing of their products. Direct Government controls were imposed during the 1930's, but producer controls were resumed after World War II. The existing commodity boards, committees, and other controlling bodies are composed jointly of producer and Government representatives.

Marketing Beef and Beef Cattle

Store Cattle

Store cattle sales are an important link in the beef marketing process. Calves, weaners, yearlings, and older cattle are transferred among breeders, rearers, and graziers primarily at local saleyards or through auction at major markets such as those at Gisborne and Te Kuiti. In recent years, a higher proportion of weaners has changed hands by private contract between individual farmers. Also, "calf liaison agencies" are providing a more orderly system of marketing dairy-origin calves suitable for beef. 18/

Slaughter Cattle for Export

The several ways of marketing cattle to be slaughtered for export are discussed below.

Selling "on schedule."--About 70 percent of adult cattle are sold on this basis (73). The seller is paid according to a national schedule of prices established by the export companies with respect to grade of meat and carcass weight. Additional payments are made for the pelt and wool. The schedule is issued weekly, based on the exporters' estimate of the price each grade of meat will bring in overseas markets in 2 to 3 months time, when it is likely to be sold. Grading standards are determined by the New Zealand Meat Producers Board.

The schedule is set by agreement among the meat exporting companies, but in practice it is usually the price set by the most optimistic exporter. To be competitive, the other exporters have to accept the highest price. The schedule is calculated by subtracting from f.o.b. realizations the procuring, slaughtering, processing, storage, and administration costs (41). This system of cartel-type (oligopsonistic) price setting is kept in check by two factors: (1) The Meat Board can express disagreement with the price in the interest of producers, even though it does not set the schedule, and (2) alternative sales outlets (discussed next) exist.

18/ The first organized sale of weaner calves from dairy farms occurred in 1967. About 7,500 weaners were transferred through these specialized sales in 1969. The growth of the dairy/beef industry has been hampered by the absence of an efficient system for marketing the new category of livestock (41).

Selling on "own account."--About 5 percent of adult cattle are sold on the owner's account. Since 1939, farmers have had the right to have stock killed for their own account by any export slaughterhouse. The meat is then sold to best advantage by the slaughterhouse company through its overseas agents. Hides and other byproducts are also processed by the company and sold on the client's behalf.

The producer receives full payment within a week of the sale of the meat, although a lag of about 3 months generally occurs between slaughter and sale. At the time of slaughter, the product is usually paid an advance--up to 90 percent of the current schedule price--but a market interest rate is charged (73).

Net earnings by this method of selling livestock have tended to exceed those obtained by selling "on schedule." There is a risk, however, in that any fall in overseas prices is borne by the producer instead of the meat trader (41).

"Selling through producer marketing cooperatives."--New Zealand has two major export marketing cooperatives--Producer Meats in the North Island and Primary Producers Cooperative Society in the South Island. These farmer cooperative organizations advance 90 percent of the current schedule price at the time of slaughter. At season's end, dividends are paid based on proceeds from the livestock sales over and above the 90-percent payment. Over the years, the cooperatives have averaged a payout exceeding the schedule payment (73).

In addition to these producer cooperatives, a number of export slaughterhouses operate on a cooperative basis. Farmers are eligible for membership and receive a rebate at season's end, based on the number of their stock which have been killed.

"Selling through saleyards."--The proportion of slaughter cattle sold through local saleyards has declined over the years. Purchases are mainly for the local trade. Sales are on a weekly or less frequent basis. Only about six saleyards of significance exist in New Zealand (73).

"Selling in the paddock or "on the hoof."--Only a small, though increasing, percentage of stock is sold by this method, which tends to be used in periods of short supply, keen competition, and high prices. The farmer and the buyer's agent negotiate a price per head of stock either at the farmgate or when delivery is made at the slaughter works. Commission costs are eliminated, but no record of carcass weights or grades is received that would be useful in improving production (41).

Selling for Local Consumption

Farmers selling slaughter cattle for local consumption generally sell through wholesalers or commission buyers. Some cattle, however, are sold directly to butchers (on an "on the hoof basis") and at local saleyard auctions. Most freezing works and many companies without their own processing plants act as wholesalers for local supply markets. Commission buyers purchase cattle for groups of butchers.

Bobby Calves

Bobby calves are sold through pools of sellers who are zoned by statute. District pool committees organize the collection, transport, and allocation of calves to the various slaughterhouses and make payments to the suppliers. Federations of pools administer marketing arrangements and (after consultation with freezing companies) recommend to district pools the amount of advance payment to suppliers.

Patterns of Livestock Selling

The seasonal pattern of livestock sales varies according to the class of animal. The peak period is in autumn (March-May), when dairy cows and beef breeding cows are culled and when young (fattening) stock are sold prior to winter to avoid costly supplementary feeding. Most cattle under 1 year of age (primarily bobby calves) are slaughter in July and August (73).

Grading

The Meat Board sets the quality grades associated with the export price schedules. Grades are established with respect to customer requirements in overseas markets. Grading standards for meat for local consumption are the responsibility of the New Zealand Department of Agriculture and are set by legislation.

A system of grading beef for export in terms of anticipated yield of red meat has been successfully introduced in Southland and Otago (South Island). This grading system uses dual criteria (yield and quality) and has been advocated for all of New Zealand as a means of raising the saleable quantity of beef (13). The percentage of cattle killed in Southland in the "yield 1" category (64-percent saleable beef or higher) is now about 80 percent, compared with 30 percent prior to introduction of the Southland-Otago grading system (198).

Carcass Weights

The average carcass weight of slaughter cattle (steer and heifers) in New Zealand declined from 596 to 512 pounds between 1965/66 and 1969/70 (194, 1971). One reason for the decline was that production efficiency and growth rates increased, so a large number of steer could be slaughtered at 18 to 20 months of age as opposed to 2-1/2 years of age or older. In addition, grading standards reduced the fat-cover requirement (in response to demand for leaner meats), which encouraged slaughter at an earlier age. Starting in the 1970 season, however, killing charges were adjusted so that, instead of a set charge per head, charges were made in relation to cattle weight. This has induced a recovery in average weights to 513 pounds in 1970/71 and 550 pounds in 1971/72 (198; 194, 1972).

Meat Producers Board

The Board was established in 1922 to control export meat operations and promote increased returns to producers. There are nine members--six nominated by the meat producers, two Government nominees, and one nominee of the Dairy Board.

Although the Board has wide statutory powers, it does not normally own or sell meat (unlike the Dairy Board in its control over New Zealand dairy exports). However, as indicated below, the Board exerts a controlling influence in practically every aspect of the industry:

1. All establishments in New Zealand that prepare meat for export must be licensed by the Meat Producers Board. 19/ The license can be granted (or revoked)

19/ There are about 30 large meat export companies in New Zealand; four handle most of the trade.

only with consent of the Minister of Agriculture, who in turn is bound by law to have the Board's approval or "give heed" to its recommendations.

2. The Board sets the grading standards for export meat and supervises the actual grading in all freezing works. It allocates available shipping space among exporters, regulates shipping, and negotiates freight rates and services. About 80 percent of New Zealand's meat exports go in shipping space programmed by the Board, inlcuding all meat to the east coast of North America, the United Kingdom, Europe, the Mediterranean, and the West Indies. The Board coordinates programs for shipping to Japan and the west coast of North America.

3. The Board conducts market research, primarily through the Meat and Wool Boards' Economic Service and through financial support to university research.

4. The Board promotes New Zealand meat in overseas markets.

5. It works to improve the quality of meat by encouraging local competition and supporting research on preparation, storage, handling, and transporation of meat products.

6. The Board administers the minimum price scheme for export meat (see section "Price Stabilization Policies").

7. Although the Board does not set the national schedule rates for meat exports, it can publicize its disagreement in the interests of producers and the trade as a whole.

To finance its operations, the Board receives a small levy from all meat exported. nterest received from the Meat Industry Reserve Account is also used (see "Price tabilization Policies").

Marketing Dairy Products

Factory-supply dairy products (90 percent of total dairy output) flow from farmers to cooperative dairy manufacturing companies, and then to the New Zealand Dairy Board for marketing. All dairy manufacturing companies are owned by the farmers who supply the milk. All dairy products are marketed by the New Zealand Dairy Board.

New Zealand Dairy Board

The Board was established in 1924 by the Dairy Industry Export Control Act. In 1934, the Board was granted greatly widened powers to regulate and control the production of dairy products and their marketing in New Zealand and overseas. Marketing control was assumed by the Government in 1936 and a system of guaranteed prices established. Control over marketing was restored to the industry in a series of steps starting in 1947, when a Dairy Products Marketing Commission was formed with equal representation by Government and industry. In 1956, the Commission was restructured with seven producer representatives and one from Government. In 1961, the Dairy Production and Marketing Board Act established a separate Marketing Commission and created a composite Dairy Production and Marketing Board. (In 1966, the 1961 titles were changed to "New Zealand Dairy Board" and "Dairy Board Act of 1961.") Presently, 11 of the Board's 13 members are selected by the cooperative dairy companies and two are Govenment appointees (187, 1972; 273).

The Dairy Board coordinates the industry's production, manufacturing, and marketing functions. It has legal authority to purchase all dairy produce manufactured

in New Zealand and intended for export. Proceeds of export sales, less marketing costs are returned to the manufacturing companies. Within New Zealand, marketing of dairy products is carried out by private firms and cooperative companies under the Board's supervision. The Board's Farm Production Division does advisory work, runs artificial insemination services, herd testing, bull progeny recording, and research into dairy cow performance.

New Zealand Milk Board

The Milk Board was established by the Milk Amendment Act of 1953 to take over from the Government administration of the national milk scheme (for domestic milk consumption). The Board is responsible for the organization of "town milk supply" in terms of production, treatment, and distribution. It reports to the Government on the adequacy of producer prices and administers the payment of a Government subsidy.

Milk Treatment Stations

Milk and cream for sale to New Zealand consumers are processed and bottled in milk treatment stations. There are 32 in the North Island and 15 in the South Island. The largest station averages 26,000 gallons daily of pasteurized milk output. About 85 percent of the milk is delivered directly to homes.

Grading and Quality Control

New Zealand was the first country to operate a compulsory system for grading dairy produce, starting with the Dairy Industry Act of 1894, which provided grading of all butter and cheese for export. There are 11 grading stores throughout New Zealand; most are located at the main ports. Nearly all are cooperatively owned, but all are administered by the New Zealand Department of Agriculture.

The purchasing price paid by the marketing authority (New Zealand Dairy Board) depends on "grading points" based on product characteristics.

Price Stabilization Policies

Most of New Zealand's major agricultural commodities are subject to some form of statutory price stabilization or direct subsidy payment. Between 1939 and 1954, price programs for meat, dairy, and wool products operated in conjunction with long-term contractual sales arrangements with the United Kingdom. Almost all these products were purchased by the United Kingdom, with only small amounts going to other destinations to retain market connections. Throughout the period, costs in New Zealand were held down fairly well, and under stabilization agreements, farm organizations agreed not to press for full payment of revenues from these sales. The result was an accumulation of considerable sums of money in various industry reserve accounts. At termination of the "bulk purchase agreements" in 1954, the meat account had a credit balance of $78 million and the dairy account, $50 million (273).

The industry reserve accounts have become the source of funds for price stabilization. Surplus profits are deposited in the accounts for use when price returns are less than certain levels (see below). The reserve funds have been used also for market development, capital investment in fertilizer and freezing works, research, and other activities.

Meat Export Prices

Minimum prices for all meat exported are determined at the beginning of every marketing year by the Meat Export Prices Committee under provisions of the Meat Export Prices Act of 1955. The Committee consists of two members of the Meat Board, two Government officials, and an independent chairman nominated by agreement between Government and producers. The Meat Board administers the minimum prices scheme on behalf of the Committee but does not itself determine prices or the amount of deficiency payments. The prices remain fixed throughout the season.

If in any week the price equivalent of the f.o.b. value of any of the basic grades of meat falls below the minimum price, a deficiency payment is declared to the extent of the difference. Meat exporters then add this amount to the price paid to producers (an addition to the schedule price) and are reimbursed by the Meat Board from the Meat Meat Industry Reserve Account. Payments have been authorized intermittently and have applied primarily to lamb and mutton.

In deciding minimum prices, the Committee must consider the average market prices for export meat over the previous 3 years; the ruling minimum prices; future market prospects; price levels of other farm products; and the general level of costs, prices, and wages in New Zealand. Minimum prices for selected classes of export meat are given in table 16. Table 17 shows data on the Meat Industry Reserve Account and deficiency payments. (Schedule prices are in table 4.)

Dairy Product Prices

Guaranteed prices (later "basic prices") for butter and cheese exports were introduced by the Government in 1936 through the Primary Products Marketing Act to give stability to the dairy industry. The cost of production was the most important criterion used in setting prices (273). Changes in pricing standards were legislated in the Dairy Products Marketing Commission Act of 1947 and, significantly, in its 1956 amendment, which states that over a period (undefined), the Dairy Industry Reserve Account must be self-balancing. In the Dairy Board Act of 1961, explicit reference to production cost was deleted, and pricing criteria (currently prevailing) emphasized market prospects and the state of the industry accounts. Specifically, the 1961 act set prices in terms of: (1) the necessity of maintaining in the public interest the stability and efficiency of the dairy industry, (2) the amounts being realized by the Dairy Board in its sales of butter and cheese and market prospects for the forthcoming year, (3) the state of the dairy industry accounts, and (4) any submissions made by the Dairy Board and other measures deemed relevant (187, 1961, 1972; 273).

In terms of the above criteria, the basic purchase price for butter is set by the Dairy Product Prices Authority. Members of this body are appointed by the Governor-General on the recommendation of the Minister of Agriculture and include three Government representatives, three nominees of the Dairy Board, and a chairman approved by the Dairy Board before appointment. The basic purchase price for cheese is then set by the Dairy Board (after consulting with the Prices Authority) in relation to the basic price for butter, together with an allowance related to the returns for casein and other solids nonfat milk products (milk powder). The objective is to ensure that suppliers of whole milk for manufacture into cheese will, on the average, receive a return equivalent to the average return they would have received had the milk been

manufactured into butter plus casein or milk powder. 20/ In addition to this pricing system designed to ensure an equitable sharing of returns on dairy produce, a companion Product Development Fund (built up from market returns on the basic dairy products butter and cheese) is intended to help maximize returns to the whole industry. The fund is held by the Dairy Board for making short-term adjustments in manufacture to meet developing or sudden changes in market requests (174, 1966).

The Dairy Board has authority to acquire ownership and market dairy products other than butter and cheese intended for export. These other products are mainly casein and skim milk powder, for which no guaranteed returns or basic prices are set. The Board operates marketing pools for each product, with returns going back to the manufacturers after deduction of marketing costs (174, 1961).

The basic prices for butter and cheese paid to dairy companies are expected to enable these companies to pay to dairy farmers (1) so many cents per pound butterfat (in cream at the farmgate) going to butter manufacture, or (2) so many cents per pound butterfat (in milk at the factory door) going to cheese manufacture. These prices to dairy farmers are shown in table 7. Basic prices in any season may not vary by more than 5 percent from the maximum prices fixed for the previous season. For other than the basic grades, there are differential premia or penalties according to "grading points."

The Dairy Board may authorize distribution to dairy companies of up to 50 percent of any surplus accruing from sales achieved in a trading year. Part or all of the balance may also be distributed at the discretion of the Minister of Agriculture. Any residual balance would go into the Reserve Account. If the deficit in the account exceeds the surplus realized from trading operations in any single year, no more than 25 percent of the surplus may be distributed to dairy processors and farmers.

Data on the Dairy Industry Reserve Account and the seasonal trading account between 1950/51 and 1971/72 are shown in table 17. As early as 1956, the Government had considered that producer prices should be based not on production costs, but on overseas realizations of dairy exports. However, following depletion of the Reserve Account in 1957/58, emergency financial assistance was obtained through a loan from the Government to sustain the industry. Between 1961 and 1971 (except for 1965), the account was in deficit. However, profits from the 1971 and 1972 seasons were sufficient cumulatively to restore the Reserve Account to a sizable surplus of $13.8 million.

20/ Cheese is purchased by the Dairy Board from the dairy factories at an advance price equal to the basic purchase price for butter plus the average of advance prices for casein and milk powder. At season's end, a final purchase price for cheese is set by the Dairy Board, equal to the butter purchase price (previously fixed) plus the estimated unit values on the season's production of casein and milk powder. This system of advance and final prices for cheese began in the 1965/66 season (174, 1966).

Table 16--Minimum prices for selected classes of export meat, North Island, New Zealand

Class of meat and basic grade 1/	1959/60	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
	Cents per pound													
Lamb--prime, 29-36	13.1	12.9	12.5	12.3	12.3	12.7	13.3	13.5	13.5	14.0	14.0	14.0	14.0	16.0
Ewe mutton--prime, 49-56 lb.	4.5	4.5	4.8	4.8	4.8	5.2	5.4	5.4	5.5	5.5	5.5	5.5	5.5	6.0
Chilled beef--ox, 451-700 lb.	11.5	12.3	12.3	12.3	12.5	12.1	12.5	13.3	13.3	15.0	15.0	16.0	17.0	19.0
Quarter beef-- ox and heifer, GAQ, 451-700 lb.	9.2	10.0	10.8	10.8	11.7	12.1	12.5	13.3	13.3	15.0	15.0	16.0	17.0	19.0
Quarter beef--cow, GAQ, 401-500 lb.	7.0	7.8	8.3	8.3	9.2	9.2	9.6	10.4	10.4	12.0	12.0	13.0	14.0	16.0
Boner beef--cow, ox, and heifer, all weights, boned-out value	8.7	9.6	10.0	10.0	11.7	11.7	12.1	15.0	16.0	18.0	18.0	19.0	20.0	22.0
Boner beef--bull, 551 lb. & over	9.2	10.0	10.0	10.0	11.7	11.7	12.1	15.0	16.0	18.0	18.0	19.0	20.0	22.0
Veal sides or quarters--under 280 lb.	7.5	8.3	9.2	9.2	9.2	9.4	10.0	11.7	11.7	12.0	12.0	13.0	14.0	16.0

1/ Basic grades for each class of meat indicated are for 1972/73 and are closely but not strictly comparable with classifications in earlier years.

Source: (194).

Table 17--Selected financial accounts for the New Zealand Meat Board and the New Zealand Dairy Board, 1950/51-1971/72

Year	Meat industry accounts 1/		Dairy industry accounts 3/	
	Deficiency Payments	Meat Industry reserve account balance	Surplus or deficit on season's trading 3/	Dairy industry reserve account balance
	Million dollars			
1950/51	--	--	8.5	46.1
1951/52	--	--	2.1	49.1
1952/53	--	--	0.8	51.1
1953/54	--	--	-2.0	50.3
1954/55	--	80.6	-2.2	49.1
1955/56	0.3	81.4	3.9	54.3
1956/57	0.2	82.6	-27.4	27.8
1957/58		84.5	-43.2	-14.7
1958/59	0.2	86.4	18.9	4.3
1959/60	1.9	86.9	-0.5	3.9
1960/61		89.6	-14.3	-10.3
1961/62	4.8	86.3	-3.1	-13.4
1962/63		88.1	4.8	-8.4
1963/64		89.5	1.2	-7.1
1964/65		90.9	9.4	0.4
1965/66		93.5	-1.1	-0.6
1966/67		95.3	-10.8	-11.2
1967/68		97.3	-1.7	-12.8
1968/69		2/	-3.2	-16.0
1969/70		100.8	-4.1	-20.1
1970/71		102.7		-20.1
1971/72		87.3	43.5	13.8

1/ As of September 30.
2/ Included in the accounting for the balance of 30 September 1970.
3/ As of May 31; for 1961 and eariler years, as of July 31.
Source: (194, 174).
Note: Dash means account was nonexistent.
Blank means zero or less than $50,000 in value.

VII. PRODUCTION RESPONSE TO PRICE CHANGES

The factors that determined the trends and patterns in New Zealand's livestock production in the 1960's provide a basis for estimating production potential in the 1970's. To quantify likely producer response to changes in the technological, economic, and institutional factors affecting production, a series of econometric models were formulated to explain past variations in livestock numbers. While a statistical model cannot capture all the elements that enter into production decisions, it can identify and measure the impact of the major factors.

Output of livestock products (beef, veal, milk, and other products) is mainly a function of cattle numbers and animal productivity. Only cattle numbers are discussed in this chapter. Animal productivity estimates are made in chapter IX and in appendix A.

Beef Cattle Numbers

Single-equation multiple regression equations were used to explain variations in beef cattle numbers during 1957-70. Price, a major explanatory factor, was treated as an independent (exogenously determined) variable because beef prices, the basis of beef cattle production, are determined in a world market that is largely inelastic to New Zealand supply (114, 116).

Furthermore, beef marketings result from previous-year decisions on beef cattle production, and current-year production decisions have a lagged effect on beef marketings (except for unusual beef herd drawdowns). Consequently, simultaneous equations models of joint supply-demand determination were not considered applicable.

The variables used in the several regressions explaining variations in cattle numbers are identified as follows:

B_t	= number of beef cattle as of January 31, current year t, in thousands.
B_{t-1}, B_{t-2}	= number of beef cattle lagged 1 and 2 years, respectively, in thousands.
PSG_{t-1}, PSG_{t-2}	= index (1960=100) of average price of weaner steers, autumn, at Gisborne, lagged 1 and 2 years, respectively.
POX_{t-1}, POX_{t-2}	= index (1960=100) of schedule price for cow beef GAQ (Good Average Quality), 801 lbs. and over, lagged 1 and 2 years, respectively.
PCB_{t-1}	= index (1960=100) of schedule price for cow beef GAQ, average for all carcass weights, lagged 1 year.
L	= number of sheep in thousands.
PF	= $ per ton of fertilizer input.
ATD	= grassland area, topdressed, in 1,000 acres.

AFD = area in feed crops, in 1,000 acres.

AGS = area in grass seed crops, in 1,000 acres.

ADC = proxy variable to quantify production stimulus from the Agricultural Development Conference, 1957-65=0 and 1966-70=1.

T = proxy variable for factors correlated with time, 1957, 1958, ...1970.

SPT = proxy variable for structural change following the ADC; SPT=(ADC) (T).

PMF = index (1960=100) of price of butterfat, in milk at the factory door (includes allowances for solids nonfat price returns).

PEC = index (1960=100) of weighted average prices of 2-tooth ewes, North Canterbury fairs, autumn.

PWL = index (1960=100) of average price for greasy wool, all qualities, at New Zealand auctions.

CFA = index of prices paid by farmers (1960=100).

Only the more important aspects and results of the regressions using the above variables are discussed.

The autumn price for weaner steers, PSG, was used in most of the response analyses because the price is determined in the open market, thereby incorporating producer anticipations of beef cattle futures and intentions to produce. PCB and POX series were also considered as possibilities, but simple regressions relating beef cattle numbers to these prices indicated better results with PSG. All three series are closely related over time.

Another important factor in producer decisions is cost. There is no data series on beef cattle production costs separate from costs of the overall sheep enterprise. Nonetheless, an index of prices paid by farmers (1960=100), CFA, was included in a number of estimating equations to explore its effects.

Regressions relating beef cattle numbers to price ratios were run to test the degree of competition between beef, dairy, and sheep production. Three price ratios (1960=100) were used: the price of beef (POX series) relative to the price of milk (PMF); the price of beef relative to the price of ewes (PEC); and the price of beef relative to the price of wool (PWL).

The price ratio coefficients had very low t-values (below 1) and were not statistically significant. The lack of a measurable relationship could have resulted because: (1) although a beef cattle industry was coming into its own in the 1960's, operations were still tied to sheep farms, and the relationship of beef cattle to sheep was still largely complementary; (2) although milk prices did not increase as rapidly as beef prices, dairy production was still more profitable than beef, and there was very little switching out of dairy to beef (and usually for utility maximization--desire for more leisure time--rather than profit maximization).

Almost all increases in beef cattle numbers in the 1960's came from sheep farms.

Of the regressions run, the four indicating the more relevant results are shown below:

Equation 1

$B_t = -2,578.43 + 3.39\ PSG_{t-2}^{***} + 0.44\ B_{t-1}^{**} + 42.33\ CFA_{t-2}^{***} + 83.23\ ADC$

$t = \quad 4.26 \quad 2.85 \quad 3.12 \quad 1.48$

$\bar{R}^2 = 0.996 \quad D\text{-}W = 3.08$

$E_s = 0.09 \quad E_1 = 0.16$

$F^{***}(4,7) = 627.78 \quad S.E. = 44.99$

Equation 2

$B_t = -2,639.66 + 4.08\ PSG_{t-2}^{***} + 0.49\ B_{t-1}^{***} = 40.94\ CFA_{t-2}^{**}$

$t = \quad 5.91 \quad 3.00 \quad 2.82$

$R^2 = 0.996 \quad D\text{-}W = 3.08$

$E_s = 0.11 \quad E_1 = 0.21$

$F^{***}(3,8) = 728.64 \quad S.E. = 48.20$

Equation 3

$B_t = -38,907.36 + 3.77\ PSG_{t-2}^{***} + 0.85\ B_{t-1}^{***} + 20.00\ T$

$t = \quad 3.76 \quad 7.44 \quad 0.96$

$\bar{R}^2 = 0.992 \quad D\text{-}W = 2.47$

$E_s = 0.10 \quad E_1 = 0.64$

$F^{***}(3,8) = 405.32 \quad S.E. = 64.53$

Equation 4

$B_t = -30,776.87 + 3.41\ PSG_{t-2}^{***} + 0.85\ B_{t-1}^{***} + 0.03\ SPT + 15.86\ T$

$t = \quad 2.83 \quad 7.13 \quad 0.60 \quad 0.69$

$b = \quad 0.16 \quad 0.76 \quad 0.04 \quad 0.08$

$\bar{R}^2 = 0.991 \quad D\text{-}W = 2.60$

$E_s = 0.09 \quad E_1 = 0.58$

$F^{***}(4,7) + 279.61 \quad S.E. = 67.29$

The symbols and letters below each regression equation have the following meaning.

* = coefficient differs significantly from zero when tested at the 10-percent probability level.

** = coefficient differs significantly from zero when tested at the 5-percent probability level.

*** = coefficient differs significantly from zero when tested at the 1-percent probability level.

t = "t" test statistic.

F = "F" test statistic.

b = beta coefficient.

$\bar{R}^2$ = coefficient of multiple determination, adjusted for degrees of freedom.

D-W = Durbin-Watson test statistic.

S.E. = Standard error of estimate.

E_s = Short-run price elasticity of beef cattle production numbers.

E_l = Long-run price elasticity of beef cattle production numbers.

Generally, the results are statistically very good. The price variable has the correct sign and the price coefficient is remarkably stable in all the analyses. As indicated by the low supply elasticities, producer response to price is very low. Specifically, holding all other factors constant, cattle numbers (in the short run) would be expected to increase about 1 percent following a 10-percent increase in price. If producers are given more time to adjust and the price remains at the higher level, the response increases to a range of 2 to 6 percent, depending on the equation used.

Prices from other past years besides the year designated in the regression equations also affect the level of cattle numbers. Since carrying prices for more than a single year often leads to intercorrelation among the several independent price variables, cattle numbers lagged 1 year was used as a proxy variable for previous prices. Further interpretations and implications of using a lagged dependent variable in the regression are given later in this section.

A dummy variable (ADC) was used to reflect a structural change that followed the promotive effort of the Agricultural Development Conference. Here it was assumed a that a higher level of production would follow the Conference, beginning in 1966.

The CFA variable (index of prices paid by farmers) in equations (1) and (2) has a positive sign contrary to causal expectation. In economic terms, a possible explanation is that CFA is a composite of prices paid by farmers and that prices have increased relatively less for those inputs (mostly labor) associated with beef cattle raising. The "relatively lower cost-push" on beef production would be an incentive over and above the "relatively higher demand-pull" that also stimulated New Zealand beef production in the 1960's.

In equation (3), the cost (CFA) variable is dropped and a trend variable (time) is used to reflect the increases in farm costs over time. However, most of the trend effect was transferred to the coefficient associated with cattle numbers lagged 1 year.

This is not surprising since cattle numbers and time both showed positive increases during the period of analyses and they are highly correlated. Because of this intercorrelation, the coefficient associated with time is not statistically significant. But the coefficient with lagged cattle numbers almost doubles in magnitude and in statistical significance.

In equation (4), the overall farm-cost variable is also left out. However, it can be reasoned that costs could be embedded implicity in the PSG (price) variations over time and that some form of "cost-plus pricing" is in operation. With steadily rising costs, prices, and production in the period of analysis, and PSG expressed at the free-market rate, this would seem a plausible deduction.

Also in equation (4), two variables (SPT and T) are carried in place of a single time variable. In contrast to equation (1), where the ADC dummy variable was used to portray a single structural shift in the level of output following the Agricultural Development Conference, the use of SPT in equation (4) assumes that there is a higher rate of increase in output over time as a full impact of the conference takes hold. Again, the T variable is a proxy for factors correlated with time which could not be explicitly included in the estimating equations--for example, productivity increases through improved technology. While the signs of these two coefficients are as expected, the coefficients are not statistically significant, and these two variables contribute very little to the estimates obtained from these equations. In using equations (3) and (4) to project cattle numbers, the projections obtained would not be materially different from projections suing these equations with the time variables omitted.

Overall regression results show that the unexplained variation in beef cattle numbers is less than 1 percent. The Durbin-Watson statistic in equations (3) and (4) indicates no positive serial correlation, but the test for negative serial correlation is inconclusive. However, the same test indicates serial correlations in equations (1) and (2). The F-ratio which tests the statistical significance of the overall regression model, is at the 1-percent level.

As stated earlier, cattle numbers lagged 1 year (B_{t-1}) has been used as a proxy variable for the influence of prices in years previous to the designated price (PSG_{t-2}). Regressions of this type indicate that production (cattle numbers, B_t) in period t is the result of a series of producer decisions over time: producers make continual adjustments in the size of herds in moving toward some desired long-run equilibrium herd size consistent with their current expectations as shaped by the most recent prices and other factors. 21/

21/ The estimating equation chosen is an econometric model of the Nerlove type, with lagged adjustment (168, 169, 82, 47). The number of beef cattle (B_t) at time t is a function of price 2 years back (PSG_{t-2}) and of the previous year's herd size (B_{t-1}). Since B_{t-1} is a function of PSG_{t-3}, B_t is also related to PSG_{t-3} and all past prices, with the more recent prices carrying more weight. The model is made dynamic by the lagged variable B_{t-1}.

In equation (4), more than half of the adjustment toward the long-run equilibrium herd size, given a price change and an absence of interfering factors (the "ceteris paribus" assumption) would occur in 5 years as determined by $1 - [(1-\gamma)]^n = 1 - [(1- .15)]^5 = 0.63$ where γ is the coefficient of adjustment. This estimate should be used with caution because the γ and long-run elasticities are senstive to specification error, but the results obtained here seem reasonable.

Thus, the regression equations account for the influence of past prices up to and including PSG_{t-2}. Price in period t-1 and t may also affect the size of beef herd (B_t) in period t; however, the study found this influence statistically nonsignificant.

The relative importance of prices in different time periods is depicted in figure 4, a schematic representation of the lagged adjustment production process in the New Zealand beef cattle industry. The sequential decisions and biological processes help explain why price (PSG_{t-2}) would exert its major impact on cattle numbers (B_t) 2 years later, in period t.

While theoretically, the adjustment process is continual, major decisions tend to be made during certain times of the year. The most important period is autumn (March-May) the peak period of adult cattle selling, when beef breeding cows are culled and young fattening stock are sold prior to winter to avoid costly supplementary feeding. It is during this period that the producer selects his options. Calves may be fattened for veal in the shortrun or kept for beef production and/or to replenish the stock of cows in the longrun. Calves on farms (numbers as of Jan. 31, when cattle numbers are officially enumerated) serve as a pool from which heifers 1 to 2 years old and steers 1 year old or older are drawn the following year. The number of calves drawn from this pool and kept rather than slaughtered would depend on price expectations for future sales versus costs of retaining the cattle.

Similarly, price and cost expectations determine whether heifers are sold for fattening or added to the cow herd. Steers 1 year old and older may be sold for fattening or held back for future sales. Cows may be kept in the breeding herd to produce calves or may be sold for slaughter to produce immediate income either by an increase in the culling rate or a reduction in the number of heifer replacements.

In view of these sequential decisions and the biological processes, the major decisions determining the number of cattle available for slaughter in period t thus occur in autumn of period t-2. Producer decisions in period t-2 to expand the beef cow herd are based on prices in that period (PSG_{t-2}). The size of the cow herd determines the next season's calf crop. This calf crop is the pool from which calves may be fattened for veal, or kept in period t-1 for future heifers or steers, depending on future expectations. Producer expectations could be altered by prices in period t-1. In period t, the heifers are added to the cow herd or slaughtered. If prices in period t are high and rising, proportionately higher numbers could be saved and fewer cows culled, resulting in a negative effect of prices on beef production in period t.

Dairy Cattle Numbers

Most of the estimating work to explain variations in dairy production and to obtain measures of production response to price changes were conducted in terms of dairy cows in milk (DCM), the class of cattle of main interest in the industry. Lagged-adjustment single equation models were used, as in the beef cattle models of production response. For the most part, prices are assumed to be at levels designed to maintain dairy producer incomes in the interests of preserving production capacity in the longerrun.

The estimating equation giving the most satisfactory results is:

Equation 5

$$DCM_t = -26{,}288.92 + 3.46\ PMF^{*}_{t-2} + 0.57\ DCM^{***}_{t-1} + 13.66\ T^{**}$$

$$t = \qquad 1.62 \qquad 4.12 \qquad 2.39$$

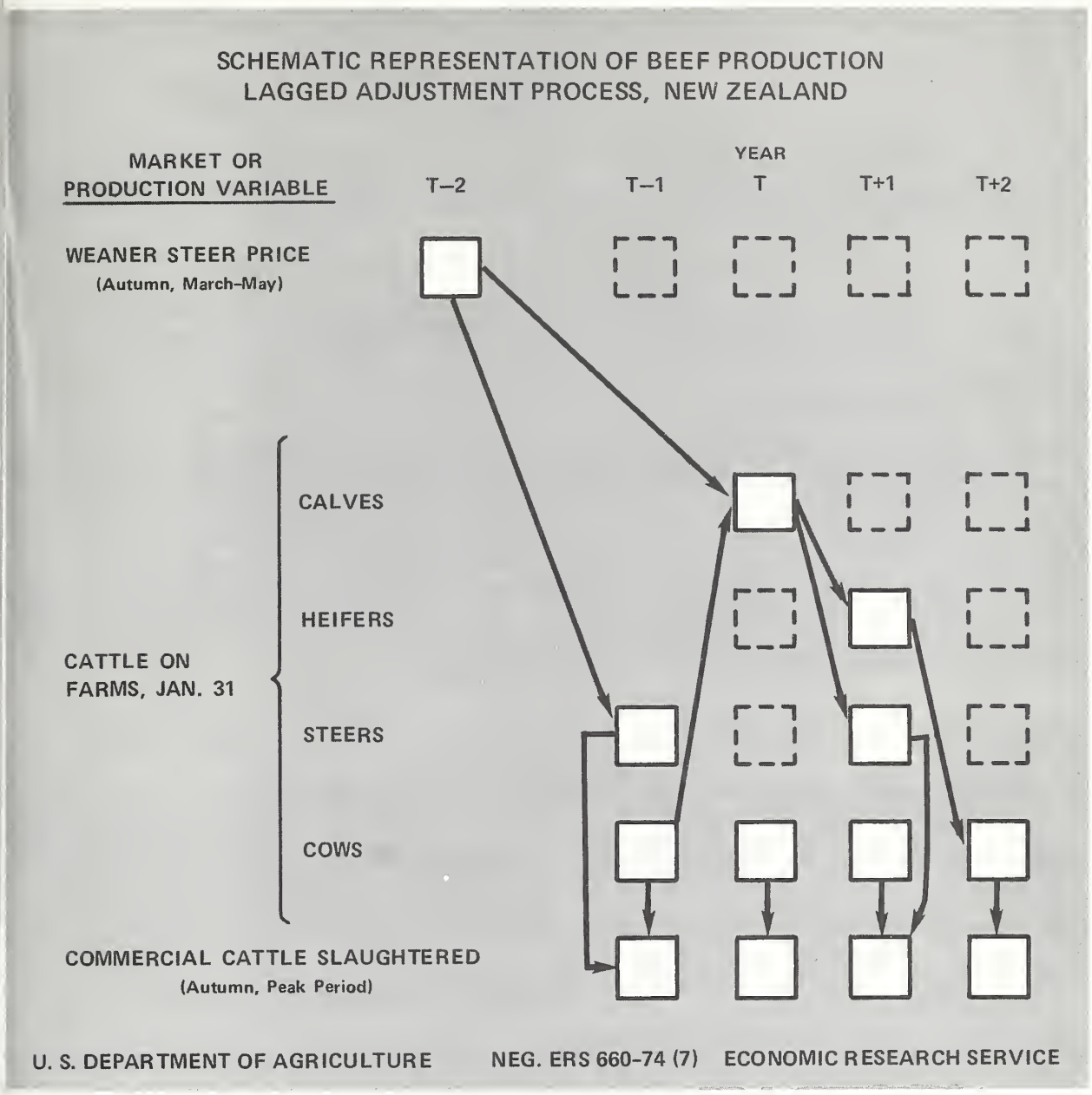
SCHEMATIC REPRESENTATION OF BEEF PRODUCTION
LAGGED ADJUSTMENT PROCESS, NEW ZEALAND
MARKET OR
PRODUCTION VARIABLE
YEAR
T–2
T–1
T
T+1
T+2
WEANER STEER PRICE
(Autumn, March–May)
CATTLE ON
FARMS, JAN. 31
CALVES
HEIFERS
STEERS
COWS
COMMERCIAL CATTLE SLAUGHTERED
(Autumn, Peak Period)
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 660-74 (7)
ECONOMIC RESEARCH SERVICE

Figure 4

b = 0.20 0.49 0.33

$\bar{R}^2$ = 0.977 D-W = 2.38

F*** = (3.8) = 141.41 S.E. = 23.64

E_s = 0.18 E_1 = 0.42

DCM_t = number of dairy cows in milk as of January 31, current year t, in thousands

DCM_{t-1} = number of dairy cows in milk, in thousands, the previous period.

PMF_{t-2} = index (1960=100) of price of butterfat, in milk at the factory door (includes allowance for solids nonfat price returns), two periods previous.

T = trend, 1957, 1958, ..., 1970

The regression results show that the model provides a good fit for the data, with unexplained variation at less than 3 percent. The number of DCM is explained largely by stock or inventory, as indicated by the beta coefficient for DCM_{t-1}. The t statistic indicates that DCM_{t-1} is significant at the 1-percent level. The Durbin-Watson statistic reveals no positive serial correlation but is inconclusive with respect to negative serial correlation in the residuals. The F ratio is significant at the 1-percent level. The price elasticity coefficient, estimated at 0.18, is higher than that for beef cattle production, but the long-run elasticity is lower, probably because of the greater market uncertainty for dairy products.

Previous Studies

Two econometric studies of New Zealand beef and dairy production response to price had been done earlier. Bergstrom (16, 1955) used pre-World War II data to estimate supply equations for dairy products and dairy cow numbers. Least squares and limited information-maximum likelihood methods of estimation were used. The price elasticities of supply turned out to be negative, however, and had to be explained in terms of satisficing (utility-maximizing, nonprofit-maximizing) behavior. The other study, by Court (47, 1967), used 1928/29 to 1960/61 data fitted into distributed-lag models to estimate the number of beef cattle sold to slaughter works. The supply price elasticities were also negative and required a number of qualifications. Further, the coefficients were not statistically significant, "perhaps reflecting...that sheep farmers do not expect much profit from beef and there are no beef cattle farms as such in New Zealand" (47, p. 295).

VIII. PASTORAL PRODUCT EXPORTS

This chapter examines the importance of pastoral exports to the New Zealand economy, the restrictive context of world trade, and trends, patterns, and prospects for New Zealand's meat and dairy exports.

Importance to the Economy

New Zealand is an export-dependent economy. Merchandise exports are about one-fifth of GNP. Pastoral products such as meats, dairy products, wool, tallow, and hides and skins comprise over 80 percent of total merchandise exports. Until the mid-1960's, they accounted for over 90 percent. In 1972, dairy product exports were valued at $340 million, about 25 percent of total export receipts. Meat exports totaled $420 million (31 percent of all exports) and wool, $225 million (17 percent of total exports) (193, June 1973).

About 70 percent of New Zealand meat production is exported (67 percent of the beef and veal, 55 percent of the mutton, and 95 percent of the lamb output). About 80 percent of butter and 90 percent of cheese production is exported (189, Feb. 1973).

Position in World Trade

New Zealand and the Netherlands are the world's leading exporters of dairy products, with each having about a 20-percent share of the world total (on a whole milk-equivalent basis) (258, FD-Feb, Aug., 1972; 258, FLM-July 1972, Mar. 1973; 65, vol. II). New Zealand was the third largest exporter of beef and veal in 1971, accounting for about 10 percent of the total compared to 19 percent for Australia and 18 percent for Argentina (258, FLM-Mar. 1973). However, New Zealand has little (if any) market power, as only about 8 percent of world dairy production, and 8 to 10 percent of beef and veal production is traded internationally. More significantly, trade is circumscribed by protective pricing and disposal programs.

New Zealand's exports of dairy and beef are restrained by various tariff and nontariff barriers in importing countries (see 193, Mar. 1971, for a listing). In the European Community (EC), the Common Agricultural Policy effectively restricts potential exports of New Zealand dairy products (except casein) by the imposition of tariffs and high variable levies to support high-cost EC dairy production. Further, the EC policy of disposing of surpluses by heavily subsidizing exports has limited New Zealand's trading possibilities in other countries. Lower prices, for example, are offered by EC countries (table 18) despite much greater production costs. In 1970, the producer price of milk in New Zealand was US $3.90 per 100 kilograms, compared with $8.30 in France, $9.72 in the Netherlands, and $8.52 in Belgium (table 19). The cost to the EC of the dairy support program has been estimated at $906 million for 1970, and about $566 million for 1971 (when higher world market prices meant lower unit costs for export refunds and subsidies) (2, Oct. 28, 1972, and May 2, 1973).

A critical matter for New Zealand is the threat of losing its major dairy market now that the United Kingdom has entered into an enlarged Economic Community (EC-9). The June 1971 Luxembourg Agreement assures New Zealand of a transition arrangement for the sale of its butter and cheese to the EC, but only through 1977 (see "Market Prospects" section). In 1962, the United Kingdom began restricting butter imports, but the quota system was really designed to protect traditional suppliers from dumping practices,

Table 18. Prices quoted for dairy products in selected Pacific markets, January to May 1969

Exporter	Commodity and market					
	Butter		Skim milk powder		Anhydrous milk fat	
	Malaysia-Singapore	Peru	Philippines	Chile	Malaysia	Peru
	U.S. dollar per ton c.i.f.					
New Zealand	584	533	200	181	638-590	590
Economic Community	518 1/	440 2/	154 1/	180 3/	590 1/	485 3/

1/ Netherlands. 2/ France. 3/ Belgium. Source: (204).

Table 19. Producer price of milk in selected countries, 1965 and 1970

Country	National monetary units	1965	1970	1970 U.S. dollars per 100 kilograms
Argentina	(Pesos/litre)	9.13	22.90	5.73
Australia	(A. $/gallon)	0.25	0.25	5.99
Austria	(Schillings/litre)	2.24	2.37	8.91
Belgium	(B.fr./kg.)	4.40	4.26	8.52
Canada	(Can. $/100 lb.)	3.37	4.05	8.84
Denmark	(D.Kr./100 kg.)	45.41	54.70	7.29
Finland	(F. mark/100 kg.)	41.32	51.31	12.22
France	(F.fr./100 kg.)	38.40	46.10	8.30
Germany, Fed. Rep. of	(DM/100 kg.)	40.40	40.20	10.98
Italy	(Lire/kg.)	67.78	79.00	12.64
Netherlands	(Guilders/100 kg.)	33.40	35.20	9.72
New Zealand	(N.Z. $/100 lb.)	1.64	1.58	3.90
Norway	(N.kr./100 kg.)	86.51	99.80	13.97
Sweden	(S.kr./100 kg.)	58.30	64.40	12.45
Switzerland	(S.fr./100 kg.)	50.50	56.30	13.04
United Kingdom	(Pence/gallon)	15.7	17.7	9.07
United States	(U.S. $/100 lb.)	4.23	5.68	12.52

Source: (64), Nov. 1971).

Table 20. Value of principal exports, New Zealand, 1959/60, 1964/65, and 1969/70 - 1970/71

Year ending June 30	Butter	Cheese	Casein	Total 2/ dairy	Beef and veal	Lamb and mutton	Total 3/ meat	Sausage casings	Tallow	Hides and skins	Wool	Total 4/ merchandise exports
	Million dollars, f.o.b.											
1959/60 1/	122.7	46.7	8.4	189.2	44.4	97.2	155.4	7.5	5.8	29.0	207.5	629.5
1964/65	119.6	40.7	16.8	197.7	57.4	135.0	212.5	11.1	7.0	31.7	208.6	742.2
1969/70	109.7	44.3	25.8	213.9	154.3	183.2	369.3	14.0	9.0	48.7	204.2	1,086.7
1970/71	113.9	48.0	30.2	228.9	170.5	186.7	391.2	14.1	10.1	50.6	187.8	1,131.7

Note: Commodity values are shown on f.o.b. valuation basis, but in many cases goods are sent out on consignment, and the selling prices are not known until the goods are disposed of at their destination. In these cases f.o.b. values are assessed on the basis of prices current at the time of export.

1/ For meats, 1959/60 is calendar year.
2/ Excludes lactose.
3/ Includes dried meat, extracts, canned, and sausages.
4/ Includes other items not specified; includes re-exports.

Source: (New Zealand Department of Statistics as cited in 194,1972; 189, Feb. 1973, June 1971).

Table 21. Volume of principal exports, New Zealand, 1959/60, 1964/65, and 1969/70 - 1970/71

Year ending June 30	Butter	Cheese	Casein	Beef and veal	Lamb and mutton	Total 1/ frozen and chilled meat	Wool
	1,000 tons						
1959/60	180.6	88.8	27.2	94.5	326.3	444.2	235.6
1964/65	189.1	93.2	51.8	119.5	360.6	511.8	237.3
1969/70	194.9	89.2	61.0	174.9	432.4	648.4	298.3
1970/71	191.4	91.2	68.4	178.0	418.6	637.8	288.9

1/ Includes other items not specified; excludes canned meats.

Source: 189, Feb. 1973, June 1971).

and as a result, New Zealand benefited. New Zealand was guaranteed two-fifths--or 173,000 tons--of total permitted imports in 1971/72. In August 1968, U.K. suppliers of cheese were asked to limit their exports; and in 1971/72, New Zealand's "quota" allocation was 75,000 tons (out of a total 135,750 tons). For beef and veal, a variable import levy system was placed in operation by the United Kingdom in July 1971. It required payment of a levy "if domestic market prices fall below a pre-determined minimum import price (194, 1971)." At the same time, import duties were introduced on fresh, chilled, or frozen mutton and lamb from all countries except Ireland. The rate of levy on lamb was 1.251 pence per pound on January 1, 1973, when the United Kingdom entered the EC (194, 1971; 193, Mar. 1972).

Japan has become New Zealand's third most important export market after the EC-9 and the United States. The potential for further dairy and meat exports to Japan is vast but presently limited by high duties and quantitative restrictions. In April 1971, however, all Japanese tariffs on sheepmeats were removed (previously, they amounted to 8 percent, c.i.f. value). In addition, the global quota for beef imports into Japan for the year ending March 1972 was raised to a record 71,500 tons (193, June 1973).

The United States is New Zealand's largest market for beef and veal exports, taking over two-thirds of the total. The U.S. Meat Import Law of 1964 (PL 88-482) provides for the imposition of quotas on chilled and frozen beef, veal, mutton, and goat meat (but not lamb) if estimates indicate that imports are likely to equal or exceed the statutory "trigger" level. The trigger level is 110 percent of an "adjusted base quota." The adjusted base quota is merely the import level obtained when the base period (1959-63 average) import level is increased by the same percentage as production has increased from the base 1959-63 average to the latest 3-year average. In effect, imports are accorded a fixed share of the market.

To assure that meat imports stayed below the trigger level, "voluntary restraint" programs for supplying countries were put in effect in 1968. Import quotas were proclaimed in 1970, but because of high U.S. meat prices, they were immediately suspended Suspension of the quota has been periodically renewed and now extends through 1974. Tariffs on beef and veal, and tariffs and global quotas on New Zealand dairy products (except casein), continue to be in effect.

Trends in Export Value and Volume

Major shifts have occurred in the relative importance of New Zealand's pastoral exports since 1960 (table 20). Dairy and wool now account for much less of total export value, while meat exports are much more important. Stimulated by rising per capita incomes and greater demand for meat in many countries of the world, meat exports accounted for almost half of the increase in total merchandise exports during 1959/60-1970/71.

Meat Exports

During 1959/60-1970/71, the value of New Zealand's meat exports rose 150 percent--from $155 million to $391 million. The value of lamb and mutton exports went up about 90 percent, from $97 million to $187 million, while volume rose about 30 percent.

Beef and veal exports almost quadrupled in value (an increase of about 280 percent), increasing from $44 million to $170 million. The volume of these exports

increased 90 percent and average f.o.b. value per ton rose 123 percent. Part of the increase in unit value is explained by the fact that export volume is expressed in product weight, the proportion of boneless beef per unit product being marketed abroad has been rising, and consequently each unit of product has acquired greater value. New Zealand used to export predominantly carcass beef (bone-in) to suit the U.K. method of distribution to consumers through butcher shops, but shifted to boned-out beef to service the market for manufacturing beef in the United States (215, 152).

Dairy Exports

Dairy product exports advanced in value about 20 percent--from $189 million in 1959/60 to $229 million in 1970/71. Leading products in terms of growth were preserved milk and cream (mostly skim milk powder) and casein, which, taken together, almost doubled in export value from $25 million to $47 million. Because prices declined, butter exports decreased 7 percent from $123 million to $114 million, despite an increase in volume exported. Cheese exports rose only 3 percent to $48 million, with volume increasing at about the same rate.

Wool and Other Exports

New Zealand's wool exports were valued at $188 million in 1970/71--about 10 percent below the 1959/60 level, despite an increase of over 20 percent in volume. Wool prices fell drastically during the period because of competition with synthetics. The increase in export volume stemmed from an expanding market for lamb and mutton, with which wool is naturally the joint product. Exports of hides and skins, and tallow, each increased almost 75 percent in value during 1959/60-1970/71.

Export Market Patterns

The United Kingdom has always been New Zealand's chief export market for pastoral products. In the 1960's, however, a great deal of market diversification occurred in anticipation of the United Kingdom's entry into the EC. Prior to this export strategy, a shift from the U.K. market had started in 1954 with the termination of agreements for U.K. bulk purchases of New Zealand's meat and dairy products (chp. VI). The termination of these agreements permitted expansion of beef and veal exports to the United States.

Market diversification during 1959/60-1970/71 was reflected in an expansion of almost 80 percent in New Zealand's export earnings. By 1971/72, about 60 percent of the value of New Zealand's meat exports was coming from outside the United Kingdom, compared with 36 percent in 1959/60. In calendar 1972, dairy exports to markets other than the United Kingdom exceeded 50 percent of the total (for the first time ever), compared with 17 percent at the beginning of the decade (table 22).

Table 23 summarizes export volume shares, by destination, for New Zealand's major pastoral exports. The data show that for butter and cheese, the United Kingdom remained the largest market during 1959/60-1971/72, accounting for 85 percent of butter exports and over 70 percent of cheese exports in 1971/72. The United States was the major market for beef and veal, with 65 percent of the total. "Other markets" (outside

Table 22. New Zealand meat and dairy export receipts by destination 1959/60, 1964/65, 1969/70 - 1971/72 1/

Product and destination	1959/60	1964/65	1969/70	1970/71	1971/72
	Million dollars				
Meat products:					
United Kingdom	99.4	143.8	190.3	177.6	183.4
United States	41.6	36.0	109.3	133.5	141.1
Japan	4.0	9.6	31.6	24.0	31.1
Canada	3.4	1.6	37.3	26.0	26.5
EC-6 and associated areas	2.4	14.4	17.4	20.4	30.9
Other	4.2	11.6	28.0	33.5	34.4
Total	155.0	217.0	413.9	415.0	447.7
Percent outside United Kingdom	35.9	33.7	54.0	57.2	59.0
Dairy products:					
United Kingdom	124.4	150.3	151.7	189.5	153. 2/
United States	5.0	8.8	21.9	19.0	23. 2/
Japan	n.a.	n.a.	16.0	11.0	28.
EC-6 and associated areas	6.2	9.6	11.4	17.4	129. 2/
Other	14.2	27.3	41.5	52.0	
Total	149.8	196.0	242.5	288.9	333. 2/
Percent outside United Kingdom	17.0	23.3	37.4	34.4	54. 2/

Note: The New Zealand dollar was devalued by 19.45 percent in November 1967, and this affects comparability.

1/ Year ended June.
2/ For calendar year ended December, 1972.

Source: (Reserve Bank of New Zealand statistics as cited in 194 1964, 1970, 1972 and 174 1964, 1969, 1972. The 1972 figures for dairy are from remarks by F. L. Onion, chairman of the Dairy Board, as cited in U.S. Foreign Agricultural Service dispatch, May 10, 1973).

Table 23--Percent of New Zealand's major meat and dairy product exports going to major destinations, 1959/60 and 1971/72

Year and destination	Butter	Cheese 2/	Beef and veal	Lamb	Mutton
	Percent of total export tonnage				
1959/60					
United Kingdom	88.5	94.5	20.4	97.1	61.0
United States	0.5	2.8	57.4	0.7	2.4
Japan	1/		3.5	1/	20.8
Other Countries	11.0	2.7	18.7	2.2	15.8
1971/72					
United Kingdom	85.1	73.4	7.1	82.2	13.2
United States	1/	6.6	64.1	2.4	1/
Japan	0.9	7.4	1.9	1.7	63.4
Other Countries	14.0	12.6	26.9	13.7	23.4

1/ Less than 0.5.
2/ 1970/71.

Source: (Appendix tables 25 and 26).

the United Kingdom, the United States, and Japan) expanded greatly during the period, accounting for 30 percent of beef and veal exports. Japan took 65 percent of New Zealand's mutton exports in 1971/72 and continues to dominate that market.

In 1960, two major steps were taken toward diversifying lamb markets. The Meat Export Development Company was established for orderly lamb marketing in the United States and Canada. In addition, a Market Development Committee was set up consisting of representatives of the Meat Pooducers Board and the meat export trade. Each year, the committee sets targets in terms of the percentage of lamb to be sold outside the United Kingdom and imposes a levy (2.5 cents per pound) on shortfalls. There has been a fair degree of success, as export tonnage to the United Kingdom in 1971/72 accounted for about 80 percent of the total, compared with 97 percent in 1959/60.

Market Prospects Through 1980

Demand prospects for New Zealand's beef and dairy products and the possibilities of less protectionist world markets will have a major bearing on the extent to which New Zealand's production potential can be fully realized.

Beef and Veal

The Food and Agriculture Organization (FAO) of the United Nations projects a world beef production deficit of 1.653 million tons by 1980 (65). Correcting for New Zealand and Australian consumption and exports as suggested by the New Zealand Meat Producers' Board (see chp. IX) would reduce the deficit to a still sizable 1.2 million tons. Another qualification to the FAO projections is that they do not account for cross-price elasticities. Thus, some shift to poultry and pigmeat would probably take place as beef prices increased relative to prices of other meats (64, Sept. 1971).

Principal countries and economic blocs whose demand for beef and veal is projected to exceed domestic supply are shown in table 24. In the case of the United Kingdom, a decrease in import requirements (relative to 1970) has been projected. As an EC member, the United Kingdom would be faced with higher prices for beef and veal, and required imports would be reduced from 330,000 tons to within a range of 122,000 to 231,000 tons. 22/

The Japanese market is naturally suited to New Zealand for reasons of distance and complementary commodity trade (37). For Japan, FAO projects a 1980 beef production deficit of 166,000 tons. This would imply per capita consumption of less than 4 kilograms a year, which seems conservative. Given Japan's high rate of economic growth (even a moderate 7 percent a year) and a fairly high income elasticity of demand (0.7), it would be difficult to restrain imports unless the Government accepted exceedingly high prices (or rationing) for beef and veal. In comparison with Japan, per capita annual consumption in the United States is projected at 61.2 kilograms, and in the United Kingdom, 24.6 kilograms.

22/ In a recent study of the EC-6, income elasticities of demand were estimated to be 0.58 for Germany, 0.21 for the Netherlands, 0.44 for France, 1.4 for Belgium, and 2.0 for Italy. But price elasticities were also high, and could hold down consumption. Price elasticities were estimated as -0.7 for Germany and for France, -1.0 for the Netherlands, -2.1 for Belgium, and -3.5 for Italy (84).

Table 24: Implied world import requirements for beef and veal in 1980, by major country and area

Country or area	1970 1/	1980
	1,000 metric tons	
United States	710	1,163
Canada	-60	35
EC-6	575	1,160
Other Western Europe	112	362
United Kingdom	480	330
Spain	110	324
Japan	25	166
Israel	60	64
Asia and Far East	20	139
Asia Centrally Planned	-76	433
Near East	115	785
U.S.S.R.	-250	1,653 2/
World		

1/ FAO estimate.
2/ This would be adjusted to 1.2 million metric tons if New Zealand and Australia exports were in carcass weight. See chapter IX.

Source: (65).

Table 25: Implied world import requirements for milk and milk products in 1980, by major country and area

Country or area	1970 1/	1980 2/
	Million metric tons, whole milk equivalent	
North America	0.13	1.95
Latin America	1.34	3.04
Other Western Europe	6.53	6.60
United Kingdom 3/	10.50	9.90
Japan	0.25	1.06
Asia and Far East	1.67	11.29
Asia Centrally Planned	-0.05	0.59
Near East	0.77	3.00
Africa	1.05	1.91
World	3.06	20.00

1/ FAO estimate.
2/ Deficits not generally expected to be translated into effective import demand.
3/ In the EC-10, 1980 import requirement of the United Kingdom would fall to 6.7-7.1 million metric tons. See (368).

Source: (65).

The projections of beef supply deficits imply higher prices through 1980. New Zealand should be in a good position to profit from the trend. However, investments in livestock production in a number of other countries have also been stimulated by the market prospect for beef. World Bank loans to increase livestock production amounted to US $120 million in 1969 and $33 million in 1970. The increase in annual beef production resulting from aggregate World Bank loans of $200 million for 20 projects is expected to amount to 423,000 tons a year. From 13 of these projects, there would be exportable supplies totaling above 200,000 tons a year (64, Sept. 1971).

Dairy Products

The future for New Zealand's exports of dairy products is quite uncertain. This stems essentially from uncertainty with respect to the pace of structural reform of dairying in the European Community and about the changes in international trade resulting from an enlarged EC that now includes Denmark, one of the world's leading dairy exporters.

The FAO projections of world import requirements show that world demand for dairy products will grow 2.2 percent a year between 1970 and 1980. A 1980 production deficit of 20 million tons of wholemilk equivalent is projected (table 25). For Japan, the projected per capita annual requirement of 1.06 kilograms seems conservative (like the FAO's beef projection). It would mean only 0.8 kilograms of cheese and 0.6 kilograms of butter per capita annually.

EC membership means higher prices for dairy products in the United Kingdom and hence, reduced U.K. demand for dairy products. For the EC-9 as a whole, net imports are projected to be small during the 1970's. However, world prices could remain considerably above the low levels of the late 1960's "as the surplus in Europe and North America are likely to remain manageable, especially since the mechanism for absorbing surpluses was substantially refined during recent years" (64, May, 1972).

Recently, the EC Council of Ministers agreed to restructure the agriculture of its member states. The program is a thinned-down version of the original (1968) Mansholt Plan. Only US $900 million of EC funds are to be made available for the first 5 years of the plan's operation (in contrast to $1.5 billion for the Mansholt proposal). The program's purpose is to foster farms that can provide incomes comparable to nonagricultural incomes, to encourage older farmers to leave agriculture, and to retrain or pension farmers (85).

The course of the world dairy market would be difficult to predict. For New Zealand, the great problem is the eventual loss of an assured cheese market and possible loss of an assured butter market in the United Kingdom. New Zealand would be able to export the EC but without any certainty of a guaranteed market and under a formidable array of protective instruments. On the other hand, the FAO projection of a basically "balanced" EC in terms of internal supply and demand implies that, at least, third-country markets could be developed by New Zealand without dumping practices by the Community to spoil the market. In the recent Luxembourg Agreement, the enlarged EC agreed to "make every effort to pursue" a trading policy that would not frustrate New Zealand's efforts to diversify its economy and exports (192). This commitment strengthens prospects for New Zealand's dairy exports to third-country markets.

The Luxembourg Agreement negotiated between the United Kingdom and the EC in June 1971 provides a continuation of New Zealand exports of butter and cheese to the U.K. market. Quantitative quarantees will be reduced over the transition period to 71 percen

(in milk-equivalent terms) of guaranteed minimum amounts, which are 170,000 tons of butter assured by the 1966 United Kingdom-New Zealand Trade Agreement, and 75,000 tons of cheese allocated under the system of voluntary restraints (192).

Year	Butter as percent of minimum	Quantity	Cheese as percent of minimum	Quantity	Milk equivalent as percent of minimum
	Percent	Metric tons	Percent	Metric tons	Percent
1973.....	96	163,200	90	67,500	95
1974.....	92	156,400	80	60,000	90
1975.....	88	149,600	60	45,000	83
1976.....	84	142,800	40	30,000	77
1977.....	80	136,000	20	15,000	71

Other provisions of the agreement are: (1) Adjustments can be made in the proportions of New Zealand butter and cheese imported into the United Kingdom so long as variations are within the total milk-equivalent prescribed, (2) the price level guaranteed to New Zealand will be the average of prices received on the U.K. market during 1969-72 23/, and (3) quantitative guarantees for cheese expire in 1978. During 1975, the EC-9 will review the situation for butter and decide on measures for ensuring continuation of quantitative and price guarantees. The review will consider production and demand trends in major dairy supplying and consuming countries, progress made by New Zealand to diversify its economy and exports, and progress toward an effective world agreement on dairy products.

The quantities subject to guarantees are minimum quantities, but depending on market conditions, New Zealand may be able to sell additional tonnages on the same basis as any other third-country supplier. Should there be any further decline in EC dairy production, such opportunities could arise (192).

No international agreement on overall dairy product marketing exists. However, under the GATT (General Agreement on Tariffs and Trade), an agreement on skim milk powder became effective in May 1970. A floor price of US$20 per 100 kilograms (9¢ per pound) on nonfat dry milk moving in international trade was established, and in May 1971, the minimum price was raised to $25 (11¢ per pound). The world market price in April 1972 was US29¢ per pound (67). In April 1973, major dairy producing countries, including New Zealand, reached agreement within the GATT framework on minimum export prices for anhydrous milkfat, ghee, and butteroil products with high butterfat content (193, June 1973).

23/ However, the price guarantees have been eroded by a U.K. decision to float the pound in June 1972. The de facto devaluation of the pound means lower prices in terms of New Zealand dollars (193, June 1973; 2, May 2, 1973).

IX. PRODUCTION AND EXPORT PROJECTIONS

Three basic sets of production projections to 1975 and to 1980 were made for New Zealand's beef and dairy industries. In set I, prices of beef cattle and milk to farmers are assumed to continue the same trends as in the recent past. In set II, the prices increase at faster rates. In set III, production is projected in terms of time trends.

The projections were generated in the following steps:

(1) For sets I and II, estimating equations developed in chapter VII were used to solve for cattle numbers sequentially, year by year, to 1980 (app. A).

(2) The cattle numbers projected in sets I, II, and III were tested for biological feasibility. The biological constraint, which consisted of the maximum possible rate of beef herd expansion to 1980, was derived from a set of plausible values for biological variables. The number of beef cattle corresponding to the maximum expansion rate was then considered as the upper physical limit on 1980 beef herd size (exclusive of dairy/beef cattle). No biological maximum was estimated for dairy cattle because production through 1980 will likely be at modest rates (app. B).

(3) Another feasibility test was imposed in the form of an institutional constraint consisting of a national target for total livestock production by 1980. The target is expressed in ewe equivalents (EE), and 1980 numbers of beef, dairy, and sheep livestock--translated into EE--were fitted within the target total to show possible tradeoffs among the livestock components (app. C).

(4) Beef, veal, and milk volume projections were derived from the livestock numbers using assumptions with respect to dairy/beef cattle numbers, carcass weights, and milk yields (app. A). Beef exclusive of dairy/beef sources was estimated by a separate function (equation 8, below).

(5) Additional assumptions were made to estimate possible production of primal beef (table beef) versus manufacturing (ground) beef in 1980 (app. D).

(6) Export availabilities for 1980 were calculated as projected production minus assumed domestic consumption.

Estimating Equations

The following regression equations were used to obtain the basic set I and set II projections.

Equation 4

$$B_t = 30{,}776.87 + 3.41\ PSG_{t-2}^{**} + 0.85\ B_{t-1}^{***} + 0.03\ SPT + 15.86T$$

Equation 5

$$DCM_t = 26{,}288.92 + 3.46\ PMF_{t-2}^{*} + 0.57\ DCM_{t-1}^{***} + 13.66\ T^{**}$$

Equation 6

$PMF = -3,699.77 + 1.94\ T^{***}$

$\bar{R}^2 = 0.79$ D-W = 1.20

Equation 7

$PSG = -16,808.84 + 8.62\ T^{***}$

$\bar{R}^2 = .074$ D-W = 1.20.

Equation 8

$BF_t = 252.37 + 0.052\ B^*_t + 0.024D_t - 42.66\ MPC^{**}$

$t = 1.62 \quad 0.31 \quad 2.60$

$\bar{R}^2 = 0.90$ D-W = 1.66

$F^{***}(3,10) = 35.55$ S.E. = 15.47

MPC represents the average annual milk yield per cow expressed in thousand pounds, and BF represents the volume of beef from all sources except dairy/beef, in thousand long tons. All other notations are as given in Chapter VII. MPC, a proxy variable to suggest profitability of culling marginal dairy cows, allows for change in the structural relationship between beef herd and dairy herd sources of beef. The number of dairy cattle, D, is taken as (DCM) (1/0.62); the correlation between D and DCM is 0.96.

Certain features of the production response models (equations 4 and 5) should be noted in the context of projections:

(1) Technological and other institutional change is allowed for, to the extent that the change is embodied in the T and SPT variable coefficients.

(2) The beef cattle model could allow for a cyclical production pattern over time by using prices derived from a cyclical price function. This was avoided, however, because (a) beef cattle numbers in New Zealand have increased steadily over time, (b) occasional offtrend beef production has been the result of ad hoc or random factors, and (c) no "beef cycle" in the sense of recurrent, predictable amplitude and periodicity, has been experienced. Through 1980, no such cycle is expected.

Production Projections, Set I

Assumptions

The following assumptions underlie projection set I:

(1) Sheep are potentially competitive with beef cattle for land use and it is assumed that beef cattle will expand at the indicated rates, at the expense of sheep if necessary. Sheep probably will increase no more than 2 percent a year during the 1970's, assuming no radical advance in lambing percentages. No separate estimating equation was developed to project sheep numbers.

(2) Most beef cattle derived from the dairy herd will be raised outside dairy farms. The beef industry will be able to expand without a reduction in dairy output, at the price ratios assumed for this study. McClatchy (144) indicates that ". . . there appears to be no reason why, at some time in the future, most of New Zealand's pasture

land could not be devoted to beef production, if changes in relative market prices for the various alternative products were to warrant such a change in output proportions." In the present study, however, the author's judgment is that no such displacement of dairy farming will occur by 1980.

(3) Very little increase, if any, is anticipated in per cow intake of concentrate at foreseeable milk/feed price ratios. Annual milk yield per cow is expected to go up moderately to an assumed 6,200 pounds. 24/ The higher percentage of Holstein-Friesian stock will tend to boost milk yields.

(4) To the extent that cost ratios change among beef, dairy and sheep enterprises the bias will be in favor of beef production because of the recency of independent beef raising enterprises, the major efforts underway to improve physical and managerial productivity, and the tendency for large leaps in productivity to occur at earlier stages of research and development.

(5) Productivity will increase enough to enable farm labor supply at about 1970 levels to adequately handle projected increases in livestock numbers. To the extent that the ratio between labor costs and other costs increases, beef production would be favored.

(6) Total occupied area will be maintained at about 44 million acres. Improved grassland, developed by aerial topdressing and oversowing, will reach about 22 million acres by 1980, and combined with higher grass yields, land carrying capacity will increase sufficiently to accommodate the projected increase in livestock numbers (216). Total carrying capacity of the land would increase to at least 130 million ewe equivalents by 1980.

(7) Enough credit would be available to allow assumption (6) to be fulfilled. It is estimated that the credit flow would be enough to permit an annual capital expenditure of about $2,500 per farm (116).

(8) Government policy will be supportive in the general lines of the past, but (a) no programs for the sheep industry comparable to the 1971-72 Stock Retention Incentive Scheme will be forthcoming, and (b) dairy industry producer prices will be sustained at the minimum sufficient to encourage production at projected levels.

(9) The export market is taken as exogenous and perfectly elastic at the prices assumed (114, 116).

(10) Undeflated prices are used in the projections. Price inflation is anticipated at about 3 percent a year in the 1970's.

(11) The price of beef (PSG) increases at 4.2 percent a year or about 50 percent during 1970-80. The price of milk (PMF) increases 1.5 percent a year or about 15 percent over the period. Both price series are derived from time trends for 1957-70 (equations 5 and 6).

Projections

At the prices given, the estimating equation generates almost 6.7 million beef cattle (exclusive of dairy/beef) for 1975 and 8.2 million for 1980. In set I, the

24/ A semi-log regression on time for average annual milk yield per cow (MPC) in the period 1960-70 had an R^2 of less than 10 percent. The regression equation projects an MPC of 6,116 pounds for 1980.

number of dairy/beef cattle--a function of dairy cattle numbers--reaches 764,000 in 1975 and 835,000 in 1980.

Total beef production would increase from 808 million pounds in 1970 to 1,402 million pounds in 1975, of which about 413 million pounds would be from dairy/beef cattle. This boost in dairy/beef production 25/ reflects the sudden advantage taken of bobby calves that used to be slaughtered at a few days of age instead of being raised for beef. If the number of dairy/beef cattle is constrained at 500,000 in 1974 (510,000 in 1975), the quantity of dairy/beef production by 1975 is reduced to 275 million pounds and total beef production would be 1,264 million pounds. By 1980, total beef production would double to 1,642 million pounds (of which 452 million pounds would be dairy/beef), and beef and veal production combined would be 1,692 million pounds (table 26).

Dairy cattle numbers are projected to reach 4.1 million by 1975 and almost 4.5 million by 1980. Milk production would increase from 13.2 billion pounds in 1970 to 15.8 billion pounds in 1975, and to 17.3 billion pounds in 1980.

Production Projections, Set II

Assumptions

In projection set II, a more expansive world demand for New Zealand beef and dairy products is postulated. Beef and milk prices increase at faster rates than under projection set I: PSG averages 7.5 percent a year, or somewhat more than doubling between 1970 and 1980; PMF increases 4 percent a year or 50 percent over the decade. These rates of increase were chosen as an arbitrary set of higher price developments in the 1970's. The other assumptions of projection set I are retained, implying a slower growth rate in sheep production (see "Institutional Limits" below).

Projections

At the higher set of prices, the beef herd and the dairy herd each increase about 7 percent over projection set I levels for 1980. Beef cattle numbers rise to 8.8 million, dairy cattle to 4.8 million, and dairy/beef cattle to 893,000. Total beef production, at 1,754 million pounds, would be almost 7 percent greater than the set I projection; milk production, at 18.5 billion pounds, would also be 7 percent greater. The incremental production response to the higher prices is moderate, as would be expected from the low price elasticity coefficients.

Production Projections, Set III

A third set of projections based on time trends was drawn up for comparative purposes. The following regression equations were used:

Equation 9

$$\log DCMT = -17.400192 + 0.027178\ TTT^{***}$$

$$\bar{R}^2 = .99 \quad D\text{-}W = 1.66 \quad S.E. = 0.002762$$

$$\log BT = -32.090619 + 0.091032\ TT^{***}$$

$$\bar{R}^2 = .45 \quad D\text{-}W = 1.09 \quad S.E. = 0.027159$$

25/ Dairy/beef production is beef from dairy/beef cattle, exclusive of beef that traditionally derived from aged and wornout dairy cows and bulls. Dairy/beef is considered primal (table beef) whereas the traditional type is of manufacturing quality.

Table 26--New Zealand: Projections of beef and dairy cattle numbers, beef and milk production, and related production categories for 1975 and 1980 1/

Projection and year	Beef cattle	Dairy cows in milk	Dairy cattle	Dairy/beef cattle	Vealers	Beef exc. from dairy/ beef cattle	Beef from dairy/ beef cattle	Total beef production	Veal production	Total beef & veal production	Milk production
	Thousands					Million pounds					
1970 (actual)	5,048.0	2,320.6	3,729.3	3/	1,150 4/	5/	5/	808.4	57.3	865.8	13,154
Projection Set I:											
1975	6,664.6	2,548.3	4,110.2	764.5	917.4	989.2	412.7	1,401.9	45.9	1,447.8	15,799
1975 2/	6,664.6	2,548.3	4,110.2	510.0	1,171.9	989.2	275.0	1,264.2	58.6	1,322.8	15,799
1980	8,210.7	2,784.6	4,491.3	835.4	1,002.5	1,189.8	451.7	1,641.5	50.1	1,691.6	17,264
Projection Set II:											
1975	6,750.1	2,596.6	4,188.1	779.0	934.8	1,003.4	417.2	1,693.0	46.7	1,739.7	16,099
1980	8,805.6	2,977.8	4,802.9	893.3	1,072.0	1,275.8	478.0	1,753.8	58.6	1,807.4	13,462
Projection Set III:											
1975	6,073.3	2,615.7	4,218.9	784.7	941.7	926.2	421.4	1,347.6	47.1	1,394.7	16,217
1980	7,421.0	2,919.7	4,709.2	875.9	1,051.1	1,109.5	474.7	1,584.2	52.6	1,636.8	18,102

1/ Set I assumes the price of beef (PSG) increases at 4.2 percent a year, and the price of milk (PMF) increases 1.5 percent a year. Set II assumes that the beef and the milk price increase 7.5 percent a year and 4 percent a year, respectively. In Set III, production is projected in terms of time trends.

2/ Assumes the number of dairy/beef cattle is constrained at 500,000 in 1974 and 510,000 in 1975.

3/ Estimated in (25) as 3 percent of the beef herd in 1969 and about 6 percent in 1970.

4/ Estimated by author.

5/ Included in "total beef."

The values were transformed with respect to time to reduce serial correlation bias. For 1980, these equations lead to projections of 7.4 million beef cattle, 4.7 million dairy cattle, 876,000 dairy/beef cattle, total beef production of 1,584 million pounds, and milk production of 18.1 billion pounds.

Comparison of Projections

For beef production excluding dairy/beef, both sets I and II projections exceed the time trend by about 7 and 15 percent, respectively:

Differences between 1980 production projections

Projection sets compared	B: Number beef cattle	D: Number dairy cattle	BF: Beef prod. excluding dairy/beef	TBF: Total beef prod.	M: Milk prod.
	Percent				
I over III	10.6	-4.6	7.2	3.6	-4.6
II over III	18.7	2.0	15.0	10.7	2.0
II over I	7.2	6.9	7.2	6.8	6.9

Source: (Table 26).

There is a definite, though moderate, price responsiveness. When dairy/beef production is included, differences among the projections of total beef production are toned down by the fact that the number of dairy cattle increases less than trend in projection set I, and exceeds trend by only 2 percent in set II. Milk output in set I would be 4.6 percent below trend and only 2 percent above trend in set II.

All three projection sets show that 1980 beef production would range between double and more than double the 1970 level. Milk output would increase considerably less--30 to 40 percent during 1970-80.

Projections in this study are compared in table 27 with projections from several other studies. Both the OECD and FAO beef and veal projections are conservative relative to the current study's projections. The actual number of beef cattle in 1971 exceeded the OECD 1975 projection of 5.14 million. The FAO study, although more recent, was not able to sufficiently account for the new emphasis on beef cattle breeding (as admitted by FAO in 68, p. 28). On the other hand, some of the New Zealand Lincoln College projections show 1979 beef cattle numbers that are higher than the current study's projections.

The dairy projections in this study are relatively high. However, under projection set I, milk production, at 17.3 billion pounds, is only 6 percent off Cartwright's 16.3 billion pounds--considered by him to be "more plausible." The most optimistic projection for dairy is the OECD's 18.1 billion pounds.

Table 27--Comparison of livestock projections for New Zealand, 1980

Study	Beef cattle	Beef breeding cows	Dairy cattle	Dairy cows in milk	Beef and veal	Milk
	----- Thousands -----				Million Pounds	
1970 (actual)	5,048	1,519	3,729	2,321	866	13,154
OECD (1968) 1/	5,712	1,828	3,940	2,522	1,039	18,059
FAO (1971)	- - - - - -	3/11,000	- - - - -		2,300	1,122	15,653
Lincoln LP (1970) 2/	2,100-9,700	630-2,900				
Cartwright (1972)						14,311-16,332
ERS:						
Projection Set I	8,211	2,466	4,491	2,785	1,692	17,264
Projection Set II	8,806	2,644	4,803	2,978	1,807	18,462
Projection Set III	7,421	2,229	4,709	2,920	1,637	18,102

1/ Interpolations of 1975 and 1985 projections.
2/ Projections are national totals for 1979. Projections are a range for different sets of assumptions.
3/ Total beef and dairy cattle.

Source: (OECD--215; FAO--(65); Lincoln LP--(114), (115), (116); Cartwright--(35); ERS--table 26).

Maximum Biological Rates of Expansion

The feasibility of the 1980 projections of beef cattle numbers was tested in terms biological variables. The limits of expansion of beef cattle from the existing breeding stock were calculated in terms of calving rates (C), heifer death rates (D), herd replacement rates (R), percentage of weaner heifers suitable for breeding (S), and age at which heifers first calve. Details of estimation are in appendix B.

The following set of assumptions was adopted for one test: C = .80, D = .03, R = .20, and S = .90. These coefficients had been estimated for hill/high country in the South Island (93), and presumably would reflect conditions less favorable than the overall New Zealand average conditions. Assuming that heifers first calve at 3 years of age, the growth rate of the beef breeding herd would stabilize at about 7.6 percent a year by the late 1970's and the size of the herd would reach 3.2 million cows or a corresponding 10.8 million beef cattle in 1980. This limit would be well outside the numbers projected by sets I-III, so that the basic projections for 1980 would be feasible. Using the same set of coefficients but assuming that heifers calve at 2 years of age, a growth rate stabilizing at 10.6 percent a year could be achieved. However, 2-year calving is still in the early stages and is not expected to be of significance in the 1970's.

In another test, with 3-year calving, the proportion of suitable heifers (S) was assumed at .75 instead of .90. The growth rate stabilized at 4.9 percent with an associated number of 2.5 million beef breeding cows and 8.2 million beef cattle in 1980. This would curtail the number of beef cattle under projection set II (8.8 million) by 600,000 beef cattle.

Institutional Limits to Livestock Expansion

Beyond the biological constraint, New Zealand's future livestock production is limited by the carrying capacity of the land. Estimates of carrying capacity have been made for New Zealand regions and New Zealand as a whole on the basis of soil types and response to fertilizer application. In 1963, the New Zealand Institute of Agricultural Science devoted its annual conference to analyzing the country's potential for agricultural expansion, and a ceiling of 150 million ewe equivalents was estimated in terms of the current technology (143, 26, 135, 260, 255, 21, and especially 52). This ceiling would easily accommodate the cattle projections made in the present study and leave a large margin of residual carrying capacity for expansion of sheep numbers.

The extent to which the land potential is realized will depend on economic incentives and the availability and cost of credit. To account for these factors, the present study assumed a lower estimate of carrying capacity for 1979/80, based on the New Zealand National Development Council's target of 130 million EE by 1978/79. At the Council's projected rate of increase of 2.6 percent a year, the 1978/79 carrying capacity would extrapolate to 133.5 million EE by 1979/80. However, the earlier target of 111 million EE by 1972/73, established at the 1964 Agricultural Development Conference, will probably be about 3 million EE short, and so a more conservative estimate of 130 million EE by 1979/80 has been used within which to fit the projections made in the current study. The time trend of livestock production in terms of EE, obtained by a semi-log regression equation with values of EE and time transformed to eliminate serial correlation, gives 130.5 million EE when used to project to 1979/80 (equation 11). Although the National Development Council's target for 1978/79 corresponds to production, not carrying capacity, the 130 million EE by 1979/80 can be interpreted as the minimum, institutionally supported, carrying capacity potential.

Equation 11

$$\log EET = -22.056688 + 0.041159\ TTTT^{***}$$

$$\bar{R}^2 = 0.726 \quad D\text{-}W = 1.27 \quad S.E. = 0.007621$$

In terms of the 130 million EE chosen as the upper limit by 1979/80, a number of possible combinations of beef cattle, dairy/beef cattle, dairy cattle, and sheep numbers may be drawn up. These are shown in table 28. Computations and assumptions are given in appendix C. Under projection set I, beef cattle numbers would reach 8.2 million or 35.7 million EE by January 31, 1980; dairy/beef cattle, 835,000 or 3.3 million EE; dairy cattle 4.5 million or 26.2 million; and the residual carrying capacity would allow 64.6 million EE or 69.1 million sheep by June 30, 1979. Sheep numbers could increase at about 1.5 percent a year, while allowing cattle to increase according to the production response models with set I price assumptions.

Under projection set II, the residual carrying capacity for sheep would be 60 million EE in 1980. This would permit a 7-percent increase in sheep numbers over 1970, to a maximum of 64.2 million sheep.

Primal and Manufacturing Beef Production

No precise data are available on production of primal (table) beef versus manufacturing or "boner" beef. However, as the beef herd is expanding faster than the dairy herd, an increasing proportion of total beef production will be of primal quality.

Using some rough assumptions, and based on projection set I, estimates of primal versus manufacturing beef production by 1980 have been calculated. Details are in appendix D.

Table 28--Selected possibilities for raising alternative numbers of beef cattle, dairy/beef cattle, dairy cattle, and sheep assuming a fully-utilized carrying capacity of 130 million ewe equivalents in New Zealand in 1979/80 1/

Possible alternatives	Beef cattle			Dairy/beef cattle 2/	Dairy cattle			Sheep		
	Total	Breeding cows and heifers	Other	Total	Total	Cows in milk	Other	Total	Ewes	Other
					Thousands					
A:		Projection Set I				Projection Set I			Residual	
Numbers	8,210.7	2,873.7	5,337.0	835.4	4,491.3	2,784.6	1,706.7	69,146.5	46,528.5	22,618.0
Ewe equivalents	35,716.5	14,368.7	21,347.8	3,341.6	26,318.0	19,492.2	6,826.8	64,622.9	46,528.5	18,094.4
B:		Projection Set II				Projection Set II			Residual	
Numbers	8,805.6	3,082.0	5,723.6	893.3	4,802.9	2,977.8	1,825.1	64,175.8	43,183.7	20,992.1
Ewe equivalents	38,304.4	15,410.0	22,894.4	3,573.2	28,145.0	20,844.6	7,300.4	59,977.4	43,183.7	16,793.7
C:		Projection Set III				Projection Set III			Residual	
Numbers	7,420.0	2,597.3	4,823.6	875.9	4,709.2	2,919.7	1,789.5	71,282.7	47,965.9	23,316.8
Ewe equivalents	32,281.2	12,986.7	19,294.5	3,503.6	27,595.9	20,437.9	7,158.0	66,619.3	47,965.9	18,653.4
D:		Projection Set II				Projection Set I			Residual	
Numbers	8,805.6	3,082.0	5,723.6	835.4	4,491.3	2,784.6	1,706.7	66,377.4	44,655.2	21,712.2
Ewe equivalents	38,304.4	15,410.0	22,894.4	3,341.6	26,319.0	19,492.3	6,826.8	62,035.0	44,655.2	17,369.8
E:		Projection Set I				Numbers at 1970 level			Residual	
Numbers	8,210.7	2,873.7	5,337.0	696.2	3,729.3	2,320.6	1,408.6	74,493.0	50,126.1	24,366.9
Ewe equivalents	35,716.5	14,368.7	21,347.8	2,784.8	21,879.1	16,244.5	5,634.6	69,619.6	50,126.1	19,493.5
F:		Projection Set II				Numbers at 1970 level			Residual	
Numbers	8,805.6	3,082.0	5,723.6	696.2	3,729.2	2,320.6	1,408.6	71,723.9	48,262.8	23,461.1
Ewe equivalents	304.4	15,410.0	22,894.4	2,784.8	21,879.1	16,244.5	5,634.6	67,031.7	48,262.8	18,768.9
G:		Projection Set I				Residual			Numbers at 1969 level	
Numbers	8,210.7	2,873.7	5,337.0	0	6,920.6	3,339.1	3,581.5	59,937.4	43,384.7	16,552.7
Ewe equivalents	35,716.5	14,368.7	21,347.8	0	37,700.0	23,374.0	14,326.0	56,626.9	43,384.7	13,242.2

1/ Each set of alternatives assumes numbers for three livestock categories and indicates a residual category. The residual livestock number is calculated from the residual carrying capacity. See Appendix C. Projection sets refer to those in table 26. 2/ Dairy/beef cattle numbers are a function of dairy cattle numbers. Alternative G, however, explores the possibility of zero numbers of dairy/beef cattle and a large increase in the diary herd.

Source: Table 26 and app. C.

Total 1980 beef production under projection set I is 1,641.5 million pounds, carcass weight. Of the total, 1,206.0 million pounds or almost 75 percent can be expected to be primal beef (compared with 40 percent in 1965/66).

Assuming domestic consumption increases at 1.8 percent a year (roughly the population growth rate), then, even if all domestic consumption were primal, there would still be 882.3 million pounds of primal beef available for export. Total export availability would be 1,317.8 million pounds, of which 67 percent would be primal beef.

Export Projections

Independent estimates of market demand for New Zealand's beef, veal, and dairy products are not an objective of this study. Instead, 1980 export availabilities are calculated as projected production minus estimates of domestic consumption.

For beef and veal, domestic consumption is derived from the FAO (65, vol. I) as corrected by the New Zealand Meat Producers Board. The correction merely adjusts the original figures to accurate carcass-weight units without changing the growth rate to 1980. 26/

For milk and milk products, domestic disappearance was partitioned into (1) human consumption and (2) use for stock feed and waste. The growth rates are derived from Cartwright (35): 2 and 3 percent a year, respectively, from the 1970 base.

Beef and veal available for export in 1980 would be 1,348 million pounds under projection set I. Export availability would range between 1,293 million pounds in projection set III and 1,463 million pounds in projection set II (table 29). 27/

In the case of milk and milk products, projection set I estimates an export volume of 12.2 billion pounds, while projection sets II and III give 13.4 billion and 13.1 billion pounds, respectively.

26/ The original figures overestimate domestic consumption by using "bone-in" production and (almost all "boneless") product weight exports. FAO recognized this but provided no revised figures. See (68, p. 22.)

27/ Production available for export is in carcass weight, i.e., bone-in. Actual exports would be in "product weight" or mostly boneless, which average about two-thirds of the carcass weight.

Table 29--Production, domestic consumption, and export availabilities of beef and veal and milk and milk products, New Zealand, 1964-66, 1970, and projections to 1980

Item	Unit	1964-66 average	1970	1980		
				Proj. I	Proj. II	Proj. III
Beef and veal 1/						
Production	1,000 m.tons	287	393	767	820	746
	Mil. lbs.	633	866	1,692	1,807	1,637
Consumption	1,000 m.tons	129	132	156	156	156
	Mil. lbs.	284	291	344	344	344
Export availability	1,000 m.tons	158	261	611	664	590
	Mil. lbs.	349	575	1,348	1,463	1,293
Milk and milk products: 2/						
Production	1,000 m.tons	5,936.0	5,966.4	7,829	8,376	8,212
	Mil. lbs.	13,086.5	13,153.5	17,264	18,462	18,102
	Mil. gal.	1,269.3	1,275.8	1,674	1,791	1,756
Human consumption	1,000 m.tons	1,572.3	1,621.8	1,978	1,978	1,978
	Mil. lbs.	3,466.2	3,575.5	4,361	4,361	4,361
	Mil. gal.	336.2	346.8	423	423	423
Fed to stock and waste	1,000 m.tons	156.2	221.7	299	299	299
	Mil. lbs.	344.4	488.7	660	660	660
	Mil. gal.	33.4	47.4	64	64	64
Total domestic consumption	1,000 m.tons	1,728.5	1,843.5	2,278	2,278	2,278
	Mil. lbs.	3,810.6	4,064.2	5,021	5,021	5,021
	Mil. gal.	369.6	394.2	487	487	487
Export availability	1,000 m.tons	4,207.5	4,122.9	5,551	6,098	5,934
	Mil. lbs.	9,275.9	9,089.3	12,243	13,441	13,081
	Mil. gal.	899.7	881.6	1,187	1,304	1,269

1/ All figures are in carcass weight, i.e., bone-in. 2/ All figures are in whole-milk equivalents. Milk for human consumption is projected to grow at 2 percent a year; for stock feed and waste, at 3 percent a year. Latest figures for domestic disappearance are given in (174) as 49.9 (1,000 LT) butter; 11.4 (1,000 LT) cheese: 6.3 (1,000LT) condensed milk and whole milk powders; 118.3 (million gallon) liquid milk and cream and ice cream. Conversion factors for product to gallon raw milk equivalent are derived from (35) as 1.765 for butter; 0.833 for cheese; 0.712 for full cream and powdered milk. Source: (35, 174, 1969, 1971: 189, 1972).

APPENDIX A--METHOD OF CALCULATING BASIC PROJECTIONS

In the following notation, the subscript t=time has been eliminated except where necessary.

B = number of beef cattle in the beef herd

DCM = number of dairy cows in milk

D = number of dairy cattle

DB = dairy/beef cattle numbers (number of dairy calves raised for beef)

V = number of vealers (number of dairy calves raised for veal)

BF = volume of beef derived from B

DBF = volume of beef derived from DB

TBF = total beef production, BF + DBF

VL = veal production

BFVL = total beef and veal production, TBF + VL

M = milk production

The estimating equations were used to project B, BF, and DCM. From these, other projection categories were estimated thusly:

$D = DCM/_{0.62}$ on the basis of historical series

$DB = 0.30\ DCM$ } as estimated below

$V = 0.36\ DCM$ }

$DBF_t = (DB_{t-1})\ (550\ lb.)$

VL = (V) (50 lb.)

M = (DCM) (6,200 lb./cow/year)

Estimation of number of dairy/beef cattle and vealers

R. Barton (10, 1966) estimated that 1,330,000 rearable calves born annually on New Zealand dairy farms were not required for dairy replacements. Of these, about 740,000 were potentially available for raising for beef or veal: 161,000 were Holstein-Friesians, 98,000 were Holstein-Friesian/Jersey crosses, and 105,000 were milking short-horn, Ayrshire, and beef-bull crosses--a total of 364,000. Barton estimated that another 100,000 beef-bull Jersey crosses or Holstein-Friesian/Jersey cross calves could be produced by Jersey cows 3 years old and over without affecting the breed composition of dairy replacement stock. In addition,

yearling Jersey heifers could be mated to Holstein-Friesian or beef bulls to give another 276,000 calves.

Barton suggests that 600,000 calves could realistically be reared for slaughter at about 20 months of age to yield a carcass weight of 550 pounds per animal. Applying Barton's estimate to the 2,032,000 dairy cows in milk in 1965, the following calculations were made:

$$600{,}000/2{,}032{,}000 = 0.30 \text{ DCM rearable for beef}$$

$$730{,}000/2{,}032{,}000 = 0.36 \text{ DCM for veal}$$

where 600,000 + 730,000 = 1,330,000, or the total number of calves not required for dairy replacements. For projections of dairy/beef and veal, the above ratios were applied to each projected number of dairy cows in milk. The 50-pound carcass weight assumed for vealers is based on the 1961-63 average of 46 pounds.

Calculating B and DCM

The estimating equations were expanded analytically to provide a general expression for projecting to any year t. Taking equation 4 as an example:

$$B_t = a + bP_{t-2} + cB_{t-1} + dSPT_t + eT_t$$

and the expanded version is:

$$\begin{aligned} B_t = {} & (1 + c^{n-(n-1)} + c^{n-(n-2)} + \ldots + c^{n-2} + c^{n-1})\, a + c^n B_{t-n} \\ & + (c^{n-1} P_{t-(n+1)} + c^{n-2} P_{t-(n)} + c^{n-3} P_{t-(n-1)} \ldots + c^{n-(n-1)} P_{t-3} \\ & + P_{t-2})b \\ & + (c^{n-1} SPT_{t-(n-1)} + c^{n-2} SPT_{t-(n-2)} + \ldots + c^{n-(n-1)} SPT_{t-1} \\ & + SPT_t)d \\ & + (c^{n-1} T_{t-(n-1)} + c^{n-2} T_{t-(n-2)} + \ldots + c^{n-(n-1)} T_{t-1} \\ & + T_t)e \end{aligned}$$

where n is the number of years projected and B_{t-n} is the base year value. When t = 1980 and n = 10 years, B_{t-n} is the value of B in 1970. This study, however, used the more tedious but simpler method of calculating B and DCM, year by year, from 1971 through 1980.

APPENDIX B--METHOD OF CALCULATING MAXIMUM SUSTAINED RATE OF INCREASE OF THE BEEF BREEDING HERD

The method outlined is from (93), with a slight difference in the derivation. Let:

R = annual replacement rate of beef breeding herd (deaths and cull losses).

C = average calving rate (survival to weaning as proportion of cows bred).

D = average annual death rate of heifers.

S = proportion of weaner heifers suitable for breeding.

BBC_t = size of beef breeding herd in year t.

W_t = number of yearling heifers in year t.

H_t = number of 2-year old heifers in year t.

Then, where the average age of first calving is 3 years old (heifers first put to bull at 2 years old):

$$BBC_t \leq BBC_{t-1} \cdot (1-R) + H_{t-1} \cdot (1-D)$$

$$H_t \leq BBC_{t-1} \cdot (1-D)$$

$$W_t \leq BBC_{t-1} \cdot C/2 \cdot (1-D) \cdot S$$

and so, $BBC_t \leq BBC_{t-1} \cdot (1-R) + C/2 \cdot BBC_{t-3} \cdot (1-D)^3 \cdot S$

and for 2-year calving:

$$BBC_t \leq BBC_{t-1} \cdot (1-R) + C/2 \cdot BBC_{t-2} \cdot (1-D)^2 \cdot S$$

Changing to an equality, BBC_t was solved for each year through 1980, using the initial values for 1968, 1969, and 1970, and different sets of assumptions with respect to the biological variables. The annual growth rates tend to stabilize in the late 1970's at the rates shown in appendix table 27. Assumption (A) represents conditions generally applicable in the South Island, and so conditions for New Zealand as a whole should be somewhat more favorable.

APPENDIX C--METHOD OF CALCULATING POSSIBILITIES FOR RAISING ALTERNATIVE NUMBERS OF CATTLE AND SHEEP ASSUMING A FULLY UTILIZED CARRYING CAPACITY OF 130 MILLION EWE EQUIVALENTS IN 1979/80

The following conversion rates were applied to livestock numbers to derive homogeneous livestock units expressed as ewe equivalents (EE) (see 179, p. 9).

Class of livestock	Ewe equivalent
Ewe (LB)	1.0
Other sheep (L-LB)	0.8
Dairy cows in milk (DCM)	7.0
Other dairy cows (D-DCM)	4.0
Beef breeding cows and beef heifers 2 years old or older (BBC+BH)	5.0
Other beef cattle [B-(BBC+BH)]	4.0
Dairy/beef cattle (DB)	4.0

Where: L = total sheep numbers
D = total dairy cattle numbers
B = total beef cattle numbers

On the basis of fairly stable historical relationships, the following ratios were assumed:

LB/L = 0.72
DCM/D = 0.62
(BBC+BH)/B = 0.35

Cattle numbers are as of January 31, 1980, and sheep numbers are as of June 30, 1979.

The calculations for possible alternative A (table 28) are used as an example. All units are in thousands.

(Projected) B = 8210.7

then BBC+BH = (0.35) (8210.7) = 2873.7, or (2873.7) (5EE) = 14,368.7EE

and B-(BBC+BH) = 5337.0, or (5337.0) (4EE) = 21,347.8EE

therefore B = 8210.7, or 14,368.7EE + 21,347.8EE = 35,716.5EE.

(Projected) DCM = 2784.6, or (2784.6)(7EE) = 19,492.2EE

then D = (2784.6) (1/0.62) = 4491.3

and D-DCM = 1706.7, or (1706.7)(4EE) = 6826.8 EE

therefore D = 4491.3, equivalent to 19,492.2EE + 6826.8EE = 26,319.0 EE.

(Projected) DB = 835.4, or (835.4) (4EE) = 3341.6 EE.

To get the residual EE in terms of sheep:

Total EE = 130,000.0
- 65,377.1 = B+D+DB = 35,716.5 EE+26,319.0 EE + 3341.6 EE
64,622.9 = L

then LB=(L) (0.72) =(64,622.9EE)(0.72)=46,528.5 EE, or 46,528.5 ewes

and (L-LB) = 64,622.9EE - 46,528.1 EE = 18,094.4EE, or (18,094.4) (1/0.8)=
23,618.0 other sheep.

APPENDIX D--METHOD OF CALCULATING PRIMAL AND MANUFACTURING BEEF PRODUCTION AND EXPORT AVAILABILITY BY 1979/80

Let:

B = beef cattle numbers

D = dairy cattle numbers

BBC = beef breeding cow numbers

DCM = number of dairy cows in milk

BF = beef production except dairy/beef, equal to PBF+MBF

PBF = primal beef production except from dairy/beef cattle

MBF = manufacturing beef production

DBF = dairy/beef production (from dairy/beef cattle, all primal)

TPBF = total primal beef production, equal to PBF+DBF

TBF = total beef production, equal to BF+DBF

About 40 percent of beef production in 1965/66 was cow beef. Not all cow beef is manufacturing beef, and some ox/heifer beef is of the manufacturing category (144), but with cow beef used as an approximation,

0.40 BF = MBF in 1965/66.

Now, DCM/BBC = 1.7 in 1965/66, and it is posited that at this ratio, the proportion of manufacturing beef to total beef production in 1980 will be the same--that is, 40 percent.

Then, $(DCM_{80})/(1.7) = BBC^{R}_{80}$ for which the 0.40 ratio of MBF/BF holds.

To the BBC^{R}_{80} would correspond a number of beef cattle B^{R}_{80} obtained by $B^{R}_{80} = (3.33)\ (BBC^{R}_{80})$, where 3.33 is the historical relationship between B and BBC.

The total number of beef cattle in 1980 is B_{80}. Therefore, $B_{80}-B^{R}_{80} = B^{D}_{80}$, the residual beef cattle (beyond the numbers dictated by the 1.7 ratio). The objective is to partition the B^{R}_{80} and the B^{D}_{80} into their respective manufacturing beef and primal beef components.

First, the amounts of beef from B^{R}_{80} and B^{D}_{80} are obtained by partitioning Eq. 8:

$$BF_{t} = a + bB_{t} + cD_{t} - dMPC$$

$$BF_{80} = BF^{R}_{80} + BF^{D}_{80} = (a^{R} + a^{D}) + b\ (B^{R}_{80} + B^{D}_{80}) + c\ (D^{R}_{80} + D^{D}_{80}) - d(MPC^{R}_{80} + MPC^{D}_{80})$$

$$BF^{R}_{80} = a^{R} + bB^{R}_{80} + cD^{R}_{80} - dMPC^{R}_{80} = (a + bB_{80} + cD_{80} - dMPC_{80})\ (B^{R}_{80}/B_{80})$$

$$BF^{D}_{80} = a^{D} + bB^{D}_{80} + cD^{D}_{80} - dMPC^{D}_{80} = (a + bB_{80} + cD_{80} - dMPC_{80})\ (B^{D}_{80}/B_{80}).$$

Now, of the BF^{R}_{80}, 40 percent is manufacturing beef and the rest primal. That is, $0.40\ BF^{R}_{80} = MBF^{R}_{80}$

$$0.60\ BF^{R}_{80} = PBF^{R}_{80};$$

And of the BF^{D}_{80}, the proportion of manufacturing beef is estimated as equal to the historical BBC/B ratio = 0.30, so that $0.30\ BF^{D}_{80} = MBF^{D}$ and $0.70\ BF^{D}_{80} = PBF^{D}_{80}$.

All dairy/beef DBF is presumed primal. Therefore, total manufacturing beef in 1980, MBF_{80}, is

$$MBF_{80} = MBF^{R}_{80} + MBF^{D}_{80}$$

and total primal beef in 1980, including dairy/beef, is equal to $PBF_{80} + DBF_{80} = TPBF_{80}$, or alternatively $TPBF_{80} = TBF_{80} - MBF_{80}$.

Using projection set I numbers for 1980, the following results are obtained. All values are in 1,000 units.

$D_{80} = 4491.3$

$DCM_{80} = 2,784.6$

$BBC^{R}_{80} = (DCM_{80})/(1.7) = 1,638.0$

$B^{R}_{80} = (BBC^{R}_{80})\ (3.33) = 5,454.5$

$B^{D}_{80} = B_{80} - B^{R}_{80} = 8210.7 - 5454.5 = 2756.2$

$B^{R}_{80}/B_{80} = 5454.5/8210.7 = 0.66$

$B^{D}_{80}/B_{80} = 2756.2/8210.7 = 0.34$

$a^{R} = (0.66)\ (a) = (0.66)\ (252.37) = 766.56$

$D^{R}_{80} = (0.66)\ (D_{80}) = (0.66)\ (4491.3) = 2964.3$

$MPC^{R}_{80} = (0.66)\ (MPC_{80}) = (0.66)\ (6) = 4.0$

$a^{D} = (0.34)(a) = (0.34)\ (252.37) = 85.81$

$D^{D}_{80} = (0.34)\ (D_{80}) = (0.34)\ (4491.3) = 1527.0$

$MPC^{D}_{80} = (0.34)\ (MPC_{80}) = (0.34)\ (6) = 2.0$

Substituting into equation 8 with the coefficients,

$BF^{R}_{80} = 766.56 + 0.052\ (5454.5) + 0.024(2964.3) - 42.66\ (4.0)$

and

BF^{D}_{80} = 85.81+0.052(2756.2)+0.024(1527.0)-42.66(2.0).

Then,

BF^{R}_{80} = 350.71 tons = 785,590.4 lb.

BF^{D}_{80} = 180.45 tons = 404,208.0 lb.

$BF^{R}_{80}+BF^{D}_{80}$ = 1,189.8 (1,000) lb.

MBF^{R}_{80} = 0.40 (BF^{R}_{80}) = 314.2 (1,000) lb.

PBF^{R}_{80} = 0.60 (BF^{R}_{80}) = 471.4 (1,000) lb.

MBF^{D}_{80} = 0.30 (BF^{D}_{80}) = 121.3 (1,000) lb.

PBF^{D}_{80} = 0.70 (BF^{D}_{80}) = 282.9 (1,000) lb.

MBF_{80} = MBF^{R}_{80} + MBF^{D}_{80} = 435.5 (1,000) lb.

MBF_{80} = MBF^{R}_{80} + MBF^{D}_{80} = 435.5 (1,000) lb.

$TPBF_{80}$ = $TBF_{80}-MBF_{80}$ = (1641.5-435.5)(1,000) lb. = 1206.0(1,000) lb. carcass weight, total primal beef production which is 0.73 of TBF_{80} compared with 0.40 of TBF in 1965/66 1/.

A minimum level of primal beef export availability may be calculated: Let domestic consumption (NZC) increase at 1.8 percent a year between 1970 and 1980 (roughly the rate of population growth). Then domestic consumption in 1980 would be

NZC_{70} = 120.9 LT, @ 1.8%/year 2/

NZC_{80} = 144.5 LT or 323.7 (1,000) lb. carcass weight. This means only 323.7/1641.5 or 20 percent of all beef production would be consumed domestically and the rest would be available for export.

New Zealand consumption is mainly of the better quality primal beef derived from price steer and prime heifer animals (144). Even if all New Zealand beef consumption were primal, there would still be a large volume of primal beef available for export:

$TPBF_{80}-NZC_{80}$ = (1206.0-323.7)(1,000) lb. = 882.3 (1,000) lb. carcass weight, primal beef available for export.

Total export availability would be 1317.8 (1,000) lb. derived by $TBF_{80}-NZC_{80}$ = (1641.5-323.7)(1,000) lb. = 1317.8 (1,000) lb.

Therefore, the minimum proportion of total beef available for export which is primal beef would be 882.3/1317.8 or 67 percent of total export availability in terms of carcass weight.

1/ In 1965/66, TBF $\approx$ BF because the number of dairy/beef cattle was insignificant.
2/ (194).

APPENDIX E--POTENTIAL USE OF FEED CONCENTRATES IN NEW ZEALAND

New Zealand imported a total of 2,416 metric tons of bran, pollard, and other feed grains (U.S. SITC 181.2) in 1970, valued at U.S. $190,000. The import unit value was US $7.86 per 100 kilograms, at US 3.5 cents per pound. 1/

At NZ 34 cents per pound of butterfat (for cheese) in 1970 equivalent to U.S. 38 cents per pound, and using the standard 4.7 percent butterfat-milk conversion rate, the milk price to the producer is NZ 1.6 cents per pound equivalent to U.S. 1.8 cents per pound. The milk-feedgrain price ratio is then 1.8/3.5 or 0.50. This means that the milk price has to double, or the cost of feedgrain imports be reduced by one-half, to get the ratio above unity.

By comparison, the U.S. milk/feed grain price ratio fluctuated monthly in 1971 within a range of 1.6 to 1.95. (The U.S. ratio is, to be precise, "pounds of concentrate ration equal in value to 1 pound of milk sold to plants.")

A second comparison might be made, with another major user of concentrates. In 1970, the Netherlands imported 592,140 metric tons of feed grains (U.S. SITC 081.2) valued at U.S. $37.156 million. The import unit value is then $6.28 per 100 kilograms or 2.8 cents per pound (a cheaper price than New Zealand paid).

The prices for milk and for various feeds in the Netherlands in 1970 were, in guilders (f) per 100 kilograms: milk (f)34.91; barley (feed) ex-farm 17 percent moisture at period of sale f32.90; oats ex-farm 16 percent moisture at period of sale f30.55; maize threshold price c.i.f. Rotterdam, August price f33.92 (Agrarstatistik, 1970). And the milk feed grain price ratios are:

milk/barley 1.06

milk/oats 1.14

milk/maize 1.03

These all exceed, by far, the New Zealand ratio.

The U.S. and Netherlands comparisons suggest that New Zealand at anywhere near current prices (cost) cannot go into concentrates for feed in a major way. As the milk price increases and higher stocking rates at greater efficiencies prevail, the scope for use of concentrates will be greater. Over the 1970's, however, feed concentrates will be used mostly for supplemental feed during grass-scarce-periods (summer, winter) in certain areas and in farms where high stocking rates and superior management would justify the expense.

1/ This compares with cost of barley meal to the farmer of NZ 3 cents per pound, equivalent to U.S. 3.4 cents per pound in the 1969/70 season, as given by Lowe (134, 1971 p. 117). R.W.M. Johnson (114, 1970, p. 34) cites a wheat price of NZ $1.35 per bushel which, at 60 pounds per bushel comes to NZ 2.25 cents per pound or U.S. 2.5 cents per pound.

APPENDIX F--CLASSES OF SHEEP FARM

The New Zealand Meat and Wool Boards' Economic Service classifies sheep farms into eight main types (200, 120):

(1) High country, South Island (Class 1 and 2S): Properties are situated at high altitudes in Canterbury, Otago, and Marlborough. Carrying capacity is low. The cover is principally native tussock, and wool is by far the most important source of revenue. This type of farming has no counterpart in the North Island.

(2) Foothill country, South Island (Class 3S): Mainly Canterbury. Carrying capacity is about one sheep to the acre. Wool is very important, as are sales of store sheep and cull ewes.

(3) Hard hill country, North Island (Class 2N): In topography, the hard hill country of the North Island is not so different from the South Island foothills, but the rainfall is higher, the winter is shorter and less severe, and cattle occupy a much more important place in the farm economy. Carrying capacity is about two sheep to the acre, plus cattle at a general ratio of one head of cattle to eight sheep. Cattle provide over a third of the revenue. Mainly on the East and West Coasts and Central Plateau.

(4) Hill country, North Island (Class 3N): Easier hill country than the preceding class and usually smaller holdings, carrying about three sheep to the acre. Cattle, again, are an important adjunct, at a general ratio of one head of cattle to 10 sheep. As a result of aerial topdressing, much of the surplus stock (other than heifers and breeding ewes--for example, steers and wether lambs) are now sold off in fat or forward condition. These farms are located throughout the North Island.

(5) Fattening-breeding farms, South Island (Class 4Se): Mainly Canterbury. These are fat-lamb farms of an extensive type, not on the most fertile land, averaging two or three sheep to the acre, and breeding most or all of their ewe replacements rather than buying them in. The country varies from flat land to rolling hills; in some districts, irrigation is undertaken and special crops are grown for fattening lambs and for winter feed. Cattle are not important.

(6) Intensive fattening farms, North Island (Class 4N): Mainly in South Auckland, Hawke Bay, and the West Coast. These farms represent grassland farming par excellence. They are on land of high fertility, either natural or induced, in relatively warm parts of the Island, most of which have reliable rainfall. Carrying capacity is high, averaging over four sheep to the acre and occasionally reaching six. Breeding ewes and cattle are usually bought in and fattened. Wool production takes second place to fattening activities.

(7) Intensive fattening farms, South Island (Class 4Si): Mainly in Southland, and in South and West Otago. This class is in many respects similar to the North Island intensive fattening farms; the main idfferences are that: (a) in the South Island, grass cannot be relied on so completely as in the North, and some feed crops are necessary, (b) more breeding of ewe replacements is done,; (c) cattle fattening is not significant (d) carrying capacity is slightly higher, at an average of four or five sheep to the acre, reaching six quite frequently; and (e) cash cropping is becoming an increasingly significant part of farm income. Wool production

is regarded as a sideline activity.

(8) Mixed fattening farms, South Island (Class 5S): These are sheep farms where a large proportion of the income (though less than half) is derived from sources other than sheep or beef cattle. Although situated on good land, these farms carry only a moderate number of sheep to the acre (two to three) because of the relatively large area devoted to grain, root crops, and seeds.

Appendix table 1--Beef cattle numbers by class of cattle, New Zealand, year ended January 31, 1956/57-1971/72

Year	Total beef cattle	Beef cows for breeding	Other beef cows	Cows culled from dairy herds	Beef heifers			Breeding bulls	Steers	Bulls and steers	
					2 years and over	1 and under 2 years	Under 1 year	2 years and over	2 years and over	1 and under 2 years	Under 1 year
	1,000 head										
1956/57...	2,861.1	860.0	71.0	32.2	169.6	273.8	315.7	32.4	493.6	289.1	323.7
1957/58...	2,915.3	896.5	66.3	30.5	173.0	283.9	339.3	33.6	453.6	296.4	342.4
1958/59...	2,969.7	917.8	58.6	27.5	166.9	312.8	348.3	34.3	417.1	325.5	360.8
1959/60...	3,019.2	968.4	56.9	27.3	175.5	313.6	388.5	-----	1,089	----------	
1960/61...	3,334.3	1,047.4	57.3	25.3	173.9	340.5	412.0	40.0	449.0	360.0	429.1
1961/62...	3,462.4	1,113.2	46.4	28.1	189.1	373.1	455.9	-----	1,257	----------	
1962/63...	3,557.9	1,113.7	48.2	20.2	226.2	386.0	547.7	-----	1,216	----------	
1963/64...	3,567.8	1,141.2	52.7	23.0	200.2	375.7	471.6	-----	1,303	----------	
1964/65...	3,627.6	1,120.0	52.1	21.7	200.5	385.2	431.6	44.4	477.3	433.7	461.1
1965/66...	3,856.1	1,214.2	40.2	29.9	197.2	393.8	472.9	45.5	504.9	443.6	513.8
1966/67...	4,241.2	1,337.9	35.9	32.7	197.9	433.3	539.5	51.5	501.6	495.9	615.0
1967/68...	4,549.1	1,448.0	34.2	30.5	199.7	478.5	573.9	52.6	504.8	583.9	643.1
1968/69...	4,811.8	1,486.3	42.7	33.6	219.5	518.8	598.5	55.7	519.5	613.1	724.0
1969/70...	5,048.0	1,518.6	42.7	68.0	236.7	532.2	634.7	64.3	527.1	661.1	762.5
1970/71...	5,279	1,557			-----	1,452	-------				
1971/72...	5,414	1,854			----------	3,655	----------				
1972/73...	5,733	1,996			----------	n.a.	----------				

Source: (188, 1965/66; 191, 1969/70; 194, 1972/73).

Appendix table 2--Dairy cattle numbers, New Zealand, year ended January 31, 1956/57-1971/72

Year	Total dairy cattle	Dairy cows and heifers, 2 years and over			Heifers		Breeding bulls 2 years and over	Bulls and bull calves under 2 years
		Cows in milk	Heifers not yet in milk	Dry cows	1 and under 2 years	Under 1 year		
	1,000							
1956/57	2,947.6	1,997.8	70.9	38.9	352.9	391.3	55.6	40.1
1957/58	2,970.2	1,966.5	72.2	36.1	375.4	423.9	52.1	44.1
1958/59	3,003.7	1,931.1	65.8	34.6	411.3	455.7	48.7	56.5
1959/60	2,972.8	1,886.7	71.3	30.7	413.5	477.1	--- 93.4 ---	
1960/61	3,111.5	1,928.8	68.8	28.7	465.3	520.1	48.5	51.3
1961/62	3,135.6	1,968.1	60.8	25.8	498.0	495.9	--- 87.0 ---	
1962/63	3,133.1	1,997.3	61.3	17.8	483.8	483.5	--- 89.3 ---	
1963/64	3,128.4	2,010.9	54.0	21.2	470.7	476.1	44.6	50.9
1964/65	3,173.8	2,032.2	56.7	24.8	464.8	501.8	39.7	53.6
1965/66	3,361.6	2,087.9	59.9	29.8	507.2	581.4	38.6	56.8
1966/67	3,505.7	2,131.4	76.4	29.2	558.0	617.7	37.1	55.9
1967/68	3,698.0	2,232.5	85.1	27.1	604.6	653.5	36.0	59.2
1968/69	3,793.1	2,304.3	85.3	25.8	627.3	646.1	37.3	66.9
1969/70	3,729.3	2,320.6	95.7	30.1	604.7	582.8	35.3	60.1
1970/71	3,539.4	2,239.0	79.2	19.9	557.9	551.3	--- 92.0 ---	
1971/72	3,359.5	2,199.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
1972/73	3,413	2,248	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

n.a. means not available.
Source: (174, 1970/71, 1972/73; 188, 1968/69).

Appendix table 3--Meat production, New Zealand, year ended September 30, 1955-71

Year	Total	Beef	Veal	Beef and veal	Mutton	Lamb	Mutton and lamb	Pig meats	Edible offal
	1,000 long tons, bone-in weights								
1955	637.2	202.1	23.4	225.5	137.9	208.0	345.9	38.8	27.0
1956	681.7	236.5	24.8	261.3	141.0	210.7	351.7	40.4	28.4
1957	669.9	240.2	26.3	266.5	125.7	209.7	335.4	37.2	30.8
1958	687.7	244.9	23.4	268.3	121.4	231.4	352.8	38.1	28.6
1959	731.3	211.3	22.8	234.1	168.4	255.3	423.7	41.2	32.2
1960	752.8	212.8	23.4	236.2	169.3	271.7	441.0	40.1	35.5
1961	757.7	212.0	24.5	236.5	168.4	281.1	449.5	39.0	32.7
1962	821.2	252.6	29.2	281.8	175.6	289.2	464.8	39.5	35.2
1963	827.7	266.2	26.9	293.1	165.8	289.5	455.3	42.0	37.4
1964	852.1	258.9	28.1	287.0	176.3	303.9	480.2	46.0	38.9
1965	822.9	246.7	24.7	271.4	169.5	298.7	468.2	44.1	39.2
1966	829.9	265.3	22.0	287.3	149.9	312.0	461.9	39.9	40.8
1967	890.8	271.4	25.6	297.0	185.5	326.9	512.4	36.0	45.5
1968	986.0	314.5	24.9	339.4	212.7	344.7	557.4	37.4	51.8
1969	1,014.1	344.2	26.3	370.5	196.7	357.1	553.8	36.4	53.3
1970	1,034.8	360.9	25.6	386.5	196.8	356.9	553.7	38.6	56.0
1971	1,040.0	365.0	21.0	386.0	200.0	355.0	555.0	43.0	56.0
1972	1,066.0	385.0	20.0	405.0	190.0	370.0	560.0	44.0	57.0
1973	1,083	420	22	442	210	335	545	37	59

Source: (188, 1968/69; 191, 1969/70; 194, 1972/73).

Appendix table 4--Production of milk and production and use of butterfat, New Zealand, 1954/55-1971/72

Season	Total milk production	Average butterfat content	Total butterfat production	Use of butterfat		
				Processed by dairy factories	Milk and cream consumed	Fed to stock and wastage
	Million gallons	Percent			Million pounds	
1954/55	1,068.3	4.56	501.5	443.5	37.5	20.1
1955/56	1,100.2	4.63	524.1	465.0	38.2	20.7
1956/57	1,084.5	4.64	518.5	459.3	38.8	20.4
1957/58	1,146.9	4.67	551.8	491.4	39.8	20.3
1958/59	1,137.9	4.69	550.1	489.4	40.6	20.0
1959/60	1,120.8	4.67	539.2	478.7	40.9	19.5
1960/61	1,129.7	4.71	548.1	487.3	41.2	19.4
1961/62	1,131.5	4.68	545.9	484.6	41.5	19.6
1962/63	1,159.0	4.68	558.1	496.1	42.3	19.5
1963/64	1,204.7	4.72	584.8	521.9	43.6	19.2
1964/65	1,281.9	4.70	620.9	556.8	44.5	19.6
1965/66	1,310.0	4.78	644.8	578.1	45.0	21.7
1966/67	1,332.4	4.75	652.3	585.2	44.8	22.3
1967/68	1,317.3	4.70	637.3	570.2	44.2	22.9
1968/69	1,376.6	4.68	662.9	594.6	44.4	23.9
1969/70	1,275.8	4.66	612.7	543.2	45.6	23.8
1970/71	1,270.8	4.69	614.5	541.9	46.5	25.8
1971/72	1,330.4	4.73	649.0	573.9	47.6	26.2
1972/73	1,281	4.73	621	549	48	26.2

Source: (174, 1970/71, 1972/73).

Appendix table 5--Dairy factory production of selected items, New Zealand, 1954/55 to 1971/72

Year	Butter	Cheese	Condensed and powdered whole milk	Skim milk powder	Buttermilk powder	Total milk powder	Casein	Lactose
	1,000 long tons							
Years ended June 30								
1955/56	204.0	96.5	14.5	35.2	12.4	62.1	14.6	4.3
1956/57	201.4	94.6	15.5	50.6	14.0	80.1	13.8	4.4
1957/58	218.8	96.5	13.6	46.1	15.8	75.5	22.5	4.4
1958/59	221.5	85.4	13.8	40.6	16.5	70.9	27.1	4.4
1959/60	211.6	93.8	16.6	49.4	15.9	81.9	24.6	4.3
1960/61	212.8	98.9	16.7	42.8	17.1	76.6	30.6	4.7
Years ended May 31								
1961/62	1/ 203.9	1/ 99.9	14.9	41.8	17.4	74.1	35.4	4.6
1962/63 2/	217.0	98.4	14.4	50.8	17.9	83.1	37.6	4.8
1963/64 2/	231.5	95.1	15.1	62.8	19.9	97.8	42.2	5.1
1964/65 2/	245.3	106.2	13.4	80.2	21.7	115.3	41.8	5.8
1965/66 2/	254.4	105.7	15.4	85.9	24.6	125.9	53.0	6.4
1966/67 2/	254.9	109.7	15.5	137.5	23.2	176.2	46.8	6.3
1967/68 2/	247.8	110.0	14.4	144.9	23.2	182.5	46.4	7.1
1968/69	267.0	96.1	17.0	133.4	23.8	174.2	67.7	8.6
1969/70	236.1	98.3	23.0	110.5	20.5	154.0	62.0	8.6
1970/71	229.1	106.1	25.0	123.0	18.7	166.7	54.8	9.0
1971/72	245.4	102.7	37.8	193.9	22.2	216.1	39.6	9.8
1972/73	238.2	97.4	34.4	186.2	22.0	208.2	45.5	9.0

1/ Ten months ended 31 May 1962.
2/ Figures exclude frozen cream.

Source: (174, 1965/66, 1972/73).

Appendix table 6--London wholesale prices for New Zealand produce, 1960 to 1972

At end of last week in March of:	Butter, finest	Cheese		Lamb, first quality			Wool 1/ Combing quality			
		Cartoned 40 lb.	(rindless-white-finest) 60 lb.	28 lb. and under	29 to 36 lb.	37 to 42 lb.	46 S.	48 S.	50 S.	56 S.
	Pounds per ton			New pence per pound			New pence per kilo			
1960	290	244	239	10-10.4	9.2-9.6	9.0-9.2	63.99	64.86	66.62	75.82
1961	250	241	239	9.4-9.6	9.0-9.2	8.1-8.3	56.54	58.51	62.89	66.62
1962	285	246	244	8.7	8.5-8.7	8.5	56	57	60	69
1963	315	246	244	8.3-8.7	8.1-8.5	8.3	59	61	67	77
1964	335	251	250	10.6-10.8	10.2	9.6-9.8	78	79	85	93
1965	350	271	270	11.0	10.6-10.8	10.6-10.8	56	57	60	67
1966	300	271	268	11.5-11.7	10.4-10.6	9.6	59	61	67	77
1967	300	271	...	10.4-10.8	10.2-10.4	10.0	53	55	59	73
1968	300	271	268	11.2-11.5	11.2-11.5	11.2	41	45	49	78
1969	300	241	238	11.7-12.1	11.5-11.9	11.2	42	46	54	68
1970	300	241	238	12.5-12.9	12.5-12.9	11.9	42	45	50	63
1971	350	296	293	14.8-15.2	13.9-14.2	12.1-12.5	43	45	49	56
1972	550	481	481	15.6-16.2	14.6-14.8	13.8-14.2	61	63	65	76

1/ Monthly averages: equivalent clean c.i.f., cost in the United Kingdom of prices recorded at New Zealand auctions and for New Zealand wool at United Kingdom auctions.

Source: (189, April 1971, May 1972).

Appendix table 7--Value, volume, and return per unit of farm product group, New Zealand, 1960/61 - 1970/71 (1960/61 = 100)

Farm product group	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71 1/
Grain and Field:											
Value	100	100	102	118	115	121	139	158	175	143	170
Volume	100	91	109	120	113	122	129	156	176	144	164
Return	100	110	94	98	102	99	108	101	99	99	104
Horticulture and Poultry:											
Value	100	111	113	124	138	151	159	159	172	171	198
Volume	100	114	128	142	148	159	164	165	167	170	150
Return	100	97	89	88	93	95	97	96	103	101	132
Wool:											
Value	100	97	114	145	109	122	103	83	98	88	78
Volume	100	101	108	106	107	121	121	123	124	122	123
Return	100	96	106	137	102	101	85	67	79	72	63
Mutton and lamb:											
Value	100	85	99	120	153	153	129	143	154	181	170
Volume	100	105	106	110	111	115	124	129	129	136	136
Return	100	81	93	109	138	133	104	111	119	133	125
Beef:											
Value	100	109	125	135	158	174	189	221	258	362	384
Volume	100	114	121	113	120	122	137	145	158	180	192
Return	100	96	103	119	132	143	138	152	163	201	200
Dairying:											
Value	100	95	98	107	124	136	142	131	129	117	132
Volume	100	98	101	104	110	117	117	115	117	109	106
Return	100	97	97	103	113	116	121	114	110	109	125
Pigs:											
Value	100	104	112	120	122	122	121	137	150	183	175
Volume	100	104	120	121	110	99	87	98	87	100	103
Return	100	100	93	99	111	123	139	140	172	183	170
All groups:											
Value	100	97	107	124	129	139	134	133	144	151	157
Volume	100	102	107	111	114	120	125	128	131	129	130
Return	100	95	100	112	113	116	107	104	110	117	121

1/ Provisional estimate.

Source: (172, 1971).

Appendix table 8--Percentage change in prices paid by New Zealand sheep and dairy farmers between 1961 and 1970 1/

Expenditure item	Percentage change
Sheep farmers:	
Wage and rations	19.8
Shearing costs	34.8
Farm requisites	5.1
Fertilizer, lime, and seeds	29.7
Vehicles, fuel, and power	13.2
Feed and grazing	46.9
Contract work	8.0
Repairs and maintenance	31.0
Railage and cartage	22.3
General expenses	35.1
Insurance	19.7
Interest	15.5
Rent	24.6
Depreciation	28.3
Other	59.2
Overall	22.9
Dairy farmers:	
Wages	16.4
Contractors	2.0
Electricity	4.4
Stock feed and veterinary	76.7
Fertilizer and seeds	16.3
Freight	21.1
Repairs and maintenance	23.5
Car and tractor	32.6
Travel	28.4
Insurance	6.1
Interest	21.9
Rent	12.7
Depreciation	21.6
Other	34.6
Overall	25.0

1/ For sheep farmers, January 1961 to January 1970. For dairy farmers, from May 1961 to May 1970.

Source: (172, 1970, 1971).

Appendix table 9--Estimated charges on New Zealand lamb from farm gate to (United Kingdom) Smithfield market, 1960/61 and 1964/65-1971/72 1/

Year	Total charges from farm gate to ex-hooks Smithfield, in N.Z. dollars	Total charges from farm gate to ex-hooks Smithfield, index (1960/61=100)
1960/61	2.47	100
1964/65	2.75	111
1965/66	2.72	110
1966/67	2.91	118
1967/68	3.12	126
1968/69	3.28	133
1969/70	3.49	141
1970/71	4.02	163
1971/72	5.85	237

1/ Calculations based on North Island prime 30 lb. lamb at January 15 each year.

Source: New Zealand Meat and Wool Boards' Economic Service, March 1972.

Appendix table 10--Dairy off-farm costs, New Zealand, 1960/61 to 1970/71

(Base 1960/61 = 1,000)

Year	Manufacturing and other charges to f.o.b., for salted butter	Freight, N.Z. to U.K.
1960/61	1,000	1,000
1961/62	998	1,000
1962/63	986	1,060
1963/64	935	1,060
1964/65	911	1,113
1965/66	922	1,113
1966/67	964	1,191
1967/68	1,021	1,236
1968/69	1,010	1,281
1969/70	1,087	1,314
1970/71	--	1/ 1,445

1/ Freight rate as from February 1971.

Source: (172, 1971).

Appendix table 11--Dairy farmers' terms of exchange, New Zealand, 1960/61 to 1970/71

(1960/61 = 1,000)

Year	Prices received	Prices paid	Terms of exchange
1960/61	1,000	1,000	1,000
1961/62	917	1,014	904
1962/63	898	1,025	876
1963/64	932	1,033	902
1964/65	1,037	1,050	988
1965/66	1,104	1,071	1,031
1966/67	1,119	1,106	1,012
1967/68	1,102	1,149	959
1968/69	1,097	1,170	938
1969/70	1/ 1,202	1,250	962
1970/71 1/	1,256	1,300	966

1/ Estimated by Agricultural Production Council.

Source: (172, 1971).

Appendix table 12--Sheep farmers' terms of exchange, New Zealand, 1960/61 to 1970/71

(1960/61 = 1,000)

Year	Prices received	Prices paid	Terms of exchange
1960/61	1,000	1,000	1,000
1961/62	951	1,016	936
1962/63	1,031	1,025	1,006
1963/64	1,187	1,025	1,158
1964/65	1,133	1,053	1,076
1965/66	1,121	1,083	1,035
1966/67	1,077	1,118	963
1967/68	1,065	1,157	920
1968/69	1,182	1,193	991
1969/70	1,255	1,228	1,022
1970/71	1,265	1,290	981

1/ Estimated by Agricultural Production Council.

Source: (172, 1971).

Appendix table 13--New Zealand Department of Statistics survey data on average income and expenditure of sheep farmers, 1960/61-1969/70

Survey item	Unit	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70
Farmers in survey	Number	896	901	902	936	925	901	952	934	932	929
Average sheep	do.	1,573	1,590	1,615	1,647	1,673	1,762	1,821	1,856	1,869	1,931
Average gross income:											
Profit from sheep	Dollars	3,648	3,166	3,710	4,432	5,379	5,107	4,679	4,945	5,597	6,478
Profit from cattle	do.	1,136	1,092	1,086	1,306	1,425	1,545	1,722	1,822	1,929	2,427
Profit from wool	do.	4,700	4,654	5,230	6,571	5,141	5,686	4,815	3,959	4,620	4,338
Total 1/	do.	10,372	9,680	10,904	13,406	13,126	13,472	12,413	11,942	13,346	14,495
Average expenditure:											
Rent	do.	206	190	216	282	315	320	332	338	353	369
Rates	do.	260	256	270	287	305	304	327	325	337	351
Interest	do.	430	472	522	540	526	633	716	749	830	893
Wages and rations	do.	1,060	1,064	1,108	1,176	1,243	1,303	1,427	1,316	1,407	1,443
Contractors	do.	348	364	400	465	513	643	594	537	609	643
Repairs & maintenance	do.	638	608	630	808	791	865	843	660	739	837
Manure and seed	do.	1,058	1,046	1,036	1,221	1,274	1,354	1,175	1,103	1,323	1,385
Freight & cartage	do.	242	238	266	287	285	307	300	279	328	375
Vehicles, fuel and power	do.	624	626	654	743	723	754	780	796	884	923
Developmental	do.	42	44	52	85	76	104	125	88	111	140
Depreciation	do.	636	642	664	712	838	851	844	790	833	879
Total 1/	do.	6,148	6,136	6,478	8,003	7,899	8,484	8,532	8,062	9,006	9,746
Average net income	do.	4,224	3,544	4,426	5,403	5,227	4,988	3,881	3,880	4,340	4,749

1/ Includes other items not specified.

Source: (189, 1961/62, 1968/69, and 1969/70 Supplements).

Appendix table 14--New Zealand Department of Statistics survey data on average income and expenditure of dairy farmers, 1960/61-1969/70

Survey item	Unit	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70
Farmers in survey	Number	1,312	1,367	1,326	1,394	1,385	1,332	1,334	1,333	1,353	1,385
Cows per farm	Number	67	69	70	72	77	82	86	90	92	98
Average gross income from sales of:											
Milk	Dollars	6,137	5,745	5,788	6,084	7,117	7,658	8,252	7,856	7,528	7,875
Livestock (exc. pigs)	do	773	714	757	756	744	911	1,105	1,319	1,707	2,038
Pigs	do	391	426	403	357	408	362	360	301	267	332
Other farm income	do	159	157	161	167	178	174	203	226	216	240
Net investment income	do	54	68	65	68	80	120	151	97	121	116
Total	do	7,514	7,110	7,174	7,432	8,527	9,225	10,171	9,799	9,839	10,601
Average expenditure for:											
Rent	do	84	86	91	102	124	131	147	154	176	165
Interest	do	267	295	330	359	369	402	438	476	558	594
Wages	do	953	944	927	906	943	982	1,162	1,164	1,291	1,338
Contractors	do	142	142	149	165	189	203	212	216	205	203
Maintenance	do	517	507	465	495	550	648	669	666	600	686
Manures and seed	do	517	548	528	573	655	668	700	697	684	734
Depreciation	do	427	450	461	482	530	583	627	668	697	728
Other	do	1,291	1,332	1,366	1,459	1,586	1,664	1,811	1,901	2,053	2,265
Total	do	4,198	4,304	4,317	4,541	4,946	5,281	5,766	5,942	6,264	6,713
Average net income	do	3,316	2,806	2,857	2,891	3,581	3,944	4,305	3,857	3,575	3,888

Source: (189, 1969/70 Supplement).

Appendix table 15--(New Zealand) Meat and Wool Boards' Economic Service survey data on average costs and returns of sheep farms, 1959/60

Survey item \ Class of farm 1/	1 and 2S High country	3S Foothill country	4Se Fattening/breeding farms	4SI Intensive fattening farms	5S Mixed fattening farms	2N Hard hill country	3N Hill country	4N Intensive fattening farms
	Dollars							
Assets:								
Sheep	25,292	15,834	11,370	8,976	7,392	23,004	15,408	10,788
Cattle	4,080	2,320	1,400	600	1,000	21,640	9,600	4,480
Total 2/	111,656	88,228	75,300	66,792	75,726	125,940	94,732	91,140
Liabilities:								
Fixed	5,114	12,342	8,922	8,726	12,282	9,268	10,378	8,806
Current	8,248	3,956	3,116	2,932	3,476	6,910	3,940	4,484
Capital net worth	97,102	71,378	62,950	55,106	59,950	108,038	80,016	77,492
Expenses:								
Wages and rations	5,276	1,738	1,730	1,056	1,818	4,600	2,474	1,964
Fertilizer, lime, and seeds	728	1,014	1,594	1,304	1,574	1,362	1,546	1,316
Feed and grazing	566	272	208	106	92	142	96	144
Repairs and maintenance	1,300	908	922	832	792	2,260	1,214	994
Depreciation	1,158	820	872	774	948	788	708	626
Interest	712	776	508	484	270	756	582	586
Rent	698	276	158	88	1,634	384	376	288
Total 2/	16,070	9,044	8,888	6,954	9,072	15,336	10,406	8,470
Gross income:								
Wool account	18,356	8,444	6,548	5,554	4,146	11,744	9,552	7,036
Sheep/lamb account	3,422	4,770	5,590	5,452	3,988	3,936	4,390	4,842
Cattle account	1,422	1,050	690	404	480	6,450	3,316	2,404
Other account	492	562	1,796	1,118	6,328	294	422	284
Total	24,192	14,826	14,624	12,528	14,942	22,424	17,680	14,566
Net farm income	8,122	5,782	5,736	5,574	5,870	7,088	7,274	6,096
Rate of return on total farm capital	7.36	6.34	6.21	7.31	7.19	5.43	7.29	6.12

1/ See Appendix F.
2/ Includes items not specified.

Source: (120).

Appendix table 16--New Zealand: Meat and Wool Boards' Economic Service survey data on average costs and returns of sheep farms, 1969/70

Survey Item \ Class of farm 1/	1 and 2S High country	3S Foothill country	4Se Fattening/ breeding farms	4SI Intensive fattening farms	5S Mixed fattening farms	2N Hard hill country	3N Hill country	4N Intensive fattening farms
	Dollars							
Assets:								
Sheep	44,313	22,159	16,596	12,919	8,737	21,648	15,143	10,504
Cattle	13,188	11,826	4,275	1,934	671	30,116	16,387	9,044
Total 2/	219,601	167,278	131,924	109,250	139,065	151,207	124,184	124,567
Liabilities:								
Fixed	32,778	36,376	36,092	21,304	32,448	24,244	24,701	23,975
Current	13,952	5,424	7,651	6,345	8,508	6,311	5,321	4,881
Capital net worth	170,136	124,408	87,401	81,345	97,784	117,849	92,430	94,954
Expenses:								
Wages and rations	5,929	2,569	1,748	1,084	2,165	3,165	1,893	1,116
Fertilizer, lime, and seeds	1,972	2,390	2,033	1,502	2,464	2,820	2,045	1,483
Feed and grazing	637	695	650	168	542	271	289	237
Repairs and maintenance	2,908	2,380	1,327	1,224	1,530	1,999	1,484	1,147
Depreciation	2,186	1,446	1,630	1,623	1,977	1,230	926	931
Interest	2,266	2,026	2,092	1,597	2,055	1,661	1,534	1,416
Rent	1,299	578	253	45	382	239	117	323
Total 2/	29,664	19,720	15,359	11,967	16,481	19,763	13,953	11,022
Gross income:								
Wool account	23,477	9,757	5,856	4,784	3,192	8,294	6,389	4,182
Sheep/lamb account	7,668	10,896	9,977	8,961	6,402	9,777	8,093	7,343
Cattle account	5,545	5,473	2,177	1,392	700	11,076	6,945	4,372
Other account	789	642	2,296	2,749	10,722	298	178	814
Total	37,479	26,768	20,306	17,886	21,016	29,445	21,605	16,711
Net farm income	7,815	7,048	4,947	5,919	4,535	9,682	7,652	5,689
Rate of return on total farm capital	3.4	4.0	3.2	4.5	2.9	5.9	5.2	3.8

1/ See appendix F.
2/ Includes items not specified.

Source: (201, 1969/70).

Appendix table 17. New Zealand Dairy Board survey data on average income and expenditure per dairy farm, 1964/65 to 1968/69 1/

Survey item	1964/65	1965/66	1966/67	1967/68	1968/69
			Dollars		
Gross income:					
Dairy produce	7,632	8,678	9,822	9,613	8,996
Bobby calves	226	248	329	382	539
Cattle	587	780	990	1,241	1,530
Pigs	650	611	645	567	386
Other stock	27	30	29	42	57
Cash crops	29	21	24	26	27
Wool and skins	33	50	51	43	45
Total 2/	9,302	10,543	12,053	12,076	11,775
Farm expenses:					
Animal health	101	134	189	213	263
Contractors	160	173	184	169	133
Electricity	133	148	166	193	209
Feed	440	482	601	645	604
Fertilizer	769	857	915	909	920
Vehicles	459	482	526	569	585
Repairs and maintenance	663	812	908	890	759
Development	45	67	84	113	69
Labor and rations	678	861	1,088	1,218	1,186
Interest	585	654	772	844	919
Rent	97	112	132	145	160
Depreciation	660	738	888	958	929
Total 2/	5,606	6,367	7,377	7,803	7,706
Net farm income	3,696	4,176	4,676	4,273	4,069
Non-farm income	82	71	74	103	99
Net income	3,778	4,247	4,750	4,376	4,168

1/ Financial year ending March 31. (Production year ends May 31.)
2/ Includes items not specified.

Source: (177, 1968/69).

Appendix table 18. Capital expenditure on farms, by farm type, as of year ending March 31, 1966 - 70

Farm type	1966	1967	1968	1969	1970
			1,000 dollars		
Principally dairy farming 1/	34,652	35,182	34,325	27,797	24,117
Principally sheep farming 1/	43,628	59,894	28,043	25,133	24,072
Principally beef farming 1/	1,427	2,493	1,788	2,034	2,683
Dairy and sheep 2/	2,804	3,271	2,418	1,978	1,780
Dairy and beef 2/	456	217	790	1,122	1,322
Sheep and dairy 2/	2,091	1,532	954	1,061	851
Sheep and beef 2/	28,024	3,454	16,534	19,079	23,118
Beef and dairy 2/	174	50	139	235	314
Beef and sheep 2/	2,098	449	1,121	1,571	2,272
Mixed livestock 3/	622	368	1,968	2,216	2,783
Sheep and cropping mixed 3/	12,951	9,937	7,374	6,444	7,065
Principally cropping 1/	2,003	2,249	2,317	2,618	2,652
General mixed farming 4/	791	692	3,656	4,262	4,315
Market farms and gardens	709	900	1,074	1,177	1,065
Other	4,295	3,228	3,030	3,092	4,013
Total	136,726	123,916	105,530	99,820	102,422

1/ At least 75 percent of gross income earned from principal activity.
2/ 50-75 percent of gross income earned from the first activity.
3/ Approximately equal percentages of gross income earned from each activity.
4/ Three or more farm activities, none earning more than 50 percent of gross income.

Sources: (187, 1971; 188, 1965/66-1969/70).

Appendix table 19. Chetwin study: Gross margins per acre

Alternative livestock activities	At 1961/62 to 1965/66 average prices		At 1965/66 prices		At 1966/67 prices	
	Dollar	(Rank)	Dollar	(Rank)	Dollar	(Rank)
Sheep -- breeding replacements.	47.97	(4)	51.68	(4)	42.16	(6)
Sheep -- buying 2-tooth replacements.	45.10	(6)	44.78	(5)	37.71	(7)
Sheep -- buying 2-year ewe replacements.	42.62	(7)	40.10	(6)	35.78	(8)
Wethers -- buying store lambs, selling 2-tooth fat stock.	56.75	(3)	39.17	(7)	28.75	(10)
Wethers -- buying 4/6-tooth store lambs, selling at 7 years.	37.11	(9)	36.10	(10)	29.80	(9)
Beef breeding -- selling 7-month weaners.	25.81	(11)	38.32	(8)	25.13	(11)
Beef fattening -- buying 7-month weaners, selling 20-month fat stock.	41.32	(8)	37.38	(9)	55.82	(3)
Beef fattening -- buying 7-month weaners, selling 30-month fat stock.	34.90	(10)	35.50	(11)	43.90	(5)
Dairy/beef fattening -- buying 3-month weaners, selling 20-month fat stock.	46.42	(5)	52.44	(3)	54.71	(4)
Dairying -- breeding replacements.	100.28	(2)	113.50	(2)	113.67	(1)
Dairying -- rearing 3 calves per cow.	105.22	(1)	133.13	(1)	103.05	(2)

Source: (40).

Appendix table 20. Trends in butterfat production per farm in New Zealand, 1950/51 - 1954/55 average to 1969/70 1/

Region	Five-year averages				Last four seasons			
	1950/51-1954/55	1955/56-1959/60	1960/61-1964/65	1965/66-1969/70	1966/67	1967/68	1968/69	1969/70
	(Milk equivalents in parentheses) 2/							
	100 pounds							
North Island	133 (2,830)	158 (3,362)	192 (4,085)	252 (5,362)	255 (5,426)	249 (5,298)	264 (5,617)	250 (5,319)
Northland	107	122	149	199	200	197	200	201
Central Auckland	106	122	150	210	211	209	219	208
South Auckland	158	191	231	293	302	285	307	286
Bay of Plenty	144	172	218	286	282	294	290	286
Central Plateau	114	151	195	250	260	258	253	225
Western Uplands	82	86	94	140	131	121	178	171
East Coast	71	79	99	123	114	98	149	150
Hawke Bay	107	131	166	218	223	211	223	230
Taranaki	174	191	226	270	272	273	285	258
Wellington	113	130	154	203	211	211	211	190
Wairarapa	132	156	190	254	260	266	256	256
South Island	86 (1,830)	89 (1,894)	105 (2,234)	136 (2,894)	132 (2,809)	137 (2,915)	135 (2,872)	151 (3,213)
New Zealand	126 (2,681)	149 (3,170)	181 (3,851)	239 (5,085)	239 (5,085)	236 (5,021)	253 (5,383)	241 (5,128)

1/ Based on butterfat supplied to factories from herds of 10 or more cows.
2/ Based on 4.7 percent butterfat-in-milk content.
Source: (175, 1969/70).

Appendix table 21--Productivity trends in New Zealand, for dairy farms using AB, 1966/67-1969/70, and comparison with non-AB users 1/

Item	Farmers using AB				Farmers not using AB
	1966/67	1967/68	1968/69	1969/70	1969/70
Farm area, in acres	138	143	148	152	142
Percent in pasture	83	87	87	87	86
Cows per 100 acres in pasture	85	84	85	90	74
Number of cows per herd	97	105	110	115	90
Butterfat per farm, in pounds	30,078	29,169	31,350	29,050	22,460
Butterfat per cow, in pounds	310	279	285	255	249
Butterfat per acre, in pounds	218	204	212	191	158
Butterfat per acre in pounds	263	234	243	230	200
Milk per farm, in pounds 2/	639,957	620,617	667,021	618,085	477,872
Milk per cow, in pounds 2/	6,596	5,936	6,064	5,426	5,298
Milk per acre, in pounds 2/	4,638	4,340	4,511	4,064	3,362
Milk per acre in pasture in pounds 2/	5,596	4,979	5,170	4,894	4,255

AB = artificial insemination.

1/ Herds if 10 or more cows, in factory-supply dairy farms earning no more than $300 from non-dairy sources.

2/ Based on 4.7 percent butterfat-in-milk content.

Source: (175, 1969/70).

Appendix table 22: Production per cow, and changes in dairy herd size, New Zealand, 1959/60 to 1971/72

Year	All cows		Tested herds 1/ 2/			Herds of 10 2/ or more cows	
	Milk production per cow	Butterfat per cow	Milk production per cow	Butterfat per cow	Average herd size	Butterfat production per cow	Average herd size
	Pound	Pound	Pound	Pound	Number	Pound	Number
1959/60	6,080	284	6,400	315	65	274	57
1960/61	6,000	282	6,300	311	68	274	59
1961/62	5,890	276	6,240	305	69	268	62
1962/63	5,940	278	6,220	307	71	270	65
1963/64	6,140	289	6,500	322	74	283	67
1964/65	6,470	304	6,650	332	77	298	70
1965/66	6,440	308	6,740	335	81	301	76
1966/67	6,420	305	6,750	331	84	298	80
1967/68	6,060	285	6,300	305	90	274	86
1968/69	6,140	287	6,530	316	94	276	92
1969/70	5,650	264	6,010	285	101	249	97
1970/71	5,850	274	6,190	295	103	257	100
1971/72	n.a.	n.a.	n.a.	320	n.a.	279	103

1/ Cows in milk 100 days or more. The cows milked in tested herds in 1969/70 represented about 30 percent of all cows in milk (175).

2/ Includes both factory-supply and town-supply herds.

Source: (174, 1971, 1972).

Appendix table 23. Stocking rates and output per acre and per labor unit for dairy farms in New Zealand, by region and herd size, 1968/69 1/

Region and herd size	Number of cows per labor unit	Number of cows per 100 acres	Butterfat per labor unit in pounds	Butterfat per acre in pounds
Region:				
North Island	68	72	19,320	204
Northland	67	48	16,410	117
Central Auckland	65	61	18,320	174
South Auckland	70	85	20,860	253
Bay of Plenty	68	82	19,190	232
Central Plateau	77	65	18,960	160
Taranaki-Western Uplands	67	77	19,680	225
Wellington	63	77	18,010	222
Wairarapa	72	85	19,690	231
Hawke Bay-East Coast	66	83	18,830	236
Nelson-Marlborough-West Coast	57	30	16,230	85
Canterbury-Otago-Southland	51	51	16,410	165
South Island	55	35	16,290	102
New Zealand	68	68	19,130	194
Herd size (number of cows):				
30-39	32	33	8,830	90
40-59	47	46	13,510	132
60-79	59	55	16,900	158
80-99	67	62	18,760	173
100-119	70	70	19,940	199
120-149	70	78	19,870	219
150-199	74	86	21,760	252
200-249	81	94	22,440	258
250-299	80	89	20,740	231
300 or more	113	110	31,410	306

1/ Factory-supply dairy farms with 30 cows or more per farm.

Source: (175, 1969/70).

Appendix table 24. Major subsidies and grants to the farming industry and allied organizations, New Zealand, 1960/61, 1966/67 - 1971/72

Subsidy or grant	1960/61	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72
	1,000 dollars						
Carriage of lime subsidy	88	102	87	90	88	128	286
Fertilizer transport subsidy	---	2,529	2,280	3,075	5,579	7,050	9,000
Fertilizer price subsidy	---	---	---	---	---	5,366	1,300
Aerial application of fertilizer and lime subsidy	---	---	---	---	---	---	700
Flood and drought relief	40	67	216	316	477	3,541	400
Special assistance fund	---	---	---	---	---	9,786	120
Dairy diversion scheme (beef)	---	---	---	---	---	1,134	2,000
Weedicide and pesticide subsidy	---	---	---	---	3,259	4,022	4,250
Subsidies under noxious weeds act	83	130	125	153	204	304	275
Subsidies to nassella tussock boards	139	157	176	174	172	190	221
Relief for eradication of bovine tuberculosis	748	1,289	1,028	1,063	1,272	1,396	2,276
Animal remedies subsidy	---	---	---	---	---	---	1,800
Subsidies and grants to pest destruction boards	1,291	1,964	1,976	1,855	1,899	2,104	2,255
National Hydatids Council	---	70	70	70	105	106	117
Herd Improvement Council	53	73	79	79	97	97	111
Veterinary Services Council	100	63	40	40	42	48	48
Agricultural Engineering Institute	---	70	83	98	125	142	190
Grant to New Zealand Wool Board	---	---	---	---	---	---	3,420

Source: (187, 1967, 1972).

Appendix table 25--Volume of meat shipped by destination and class of meat, New Zealand, 1959/60, 1964/65, 1969/70-1971/72

Destination	Beef and veal	Lamb	Mutton	Total 1/	Beef and veal	Lamb	Mutton	Total 1/
	1,000 tons, shipping (product) weight							
	1959/60 2/				1964/65 4/			
United Kingdom	20.3	251.1	46.2	343.9	29.3	259.3	28.3	350.5
United States	57.2	1.9	1.8	61.3	45.6	5.9	0.3	52.9
Japan	3.5	0.1	15.8	19.6	2.8	0.4	42.8	46.3
Other Countries	18.7	5.5	12.0	41.0	35.0	13.6	12.7	69.4
Total	99.6	258.6	75.8	465.8	112.7	279.2	84.1	519.1
Percent outside U.K.	79.6	2.9	39.0	26.2	74.0	7.1	66.4	32.5
	1969/70 3/				1970/71 3/			
United Kingdom	14.8	286.9	20.1	369.6	14.1	287.3	22.4	365.2
United States	90.2	10.7	0.5	101.8	114.4	6.1	0.08	121.2
Japan	2.5	5.8	64.7	75.0	4.1	3.0	59.7	69.3
Other Countries	66.9	26.6	16.4	119.6	59.9	35.5	29.5	136.0
Total	174.5	330.0	101.2	666.0	192.5	331.9	111.6	691.6
Percent outside U.K.	91.5	13.1	80.2	44.5	92.7	13.4	80.0	47.2
	1971/72 3/							
United Kingdom	12.5	274.9	13.0	345.6				
United States	112.8	8.0	0.3	121.6				
Japan	3.4	5.7	62.5	74.4				
Other Countries	47.2	45.7	23.1	126.0				
Total	175.9	334.3	98.6	667.6				
Percent outside U.K.	92.9	17.8	86.9	48.2				

1/ Includes pigmeat offal and others not specified; excludes canned meat.
2/ From 1959/60 production, shipped in Oct. 1, 1959-Sept. 30, 1960.
3/ Season ending September 30.
4/ From 1964/65 production, shipped in Oct. 1, 1964-Apr. 30, 1966.
Source: (New Zealand Meat Producers Board --194, 1961, 1966, 1970-1972).

Appendix table 26--Volume of butter and cheese exported by destination, New Zealand, 1959/60, 1964/65, 1969/70-1971/72 1/

Destination	Butter					Cheese 2/				
	1959/60	1964/65	1969/70	1970/71	1971/72	1959/60	1964/65	1969/70	1970/71	1971/72
	1,000 tons									
United Kingdom	145.2	174.9	173.6	157.5	131.3	81.9	80.5	68.0	66.8	n.a.
United States	0.9	0.2	0.2	0.2	0.2	4/ 2.4	4.0	6.9	6.0	5/ 6.2
Japan	3/	3/	3/	3/	1.4	n.a.	1.7	6.9	6.7	5/ 7.8
Asia except Japan	1.1	1.4	1.1	1.5	1.4	n.a.		0.4	1.0	1.4
Caribbean, Central & South America	6.1	5.0	5.2	6.6	10.4	1.8	3.1	4.5	6.7	5.1
Germany	4.0	0.4	0.3	0.3	0.4	0.1	1.7	0.6	0.3	n.a.
Other	6.9	5.4	1.5	9.3	9.2	0.5	2.3	1.9	3.5	n.a.
Total	164.1	187.2	182.0	175.3	154.3	86.7	93.2	89.2	91.0	n.a.
Percent outside U.K.	11.5	6.6	4.6	10.2	14.9	5.5	13.6	23.8	28.6	n.a.

1/ 1959/60-1970/71 are for years ended June 30. 1971/72 is for year ended May 31.
2/ Natural and processed cheese combined.
3/ Less than 100 tons.
4/ North America
5/ Natural cheese only.

Source: (New Zealand Dairy Board--174, 1965, 1968, 1971-72).

Appendix table 27--Maximum sustained rate of increase of the beef breeding herd and numbers of beef cattle in New Zealand under alternative biological assumptions

Biological variables / Biological assumptions	S	R	C	D	Rate of growth stabilizes by 1980 at (percent)	New Zealand Numbers by 1980		South Island Numbers by 1980	
						Beef breeding cows (1,000)	Beef cattle (1,000)	Beef breeding cows (1,000)	Beef cattle (1,000)
Three-year calving									
(A)	.90	.20	.80	.03	7.6	3,229	10,753	966	3,218
(B)	.80	.20	.80	.03	6.0	2,767	9,213	576	1,918
(C)	.80	.15	.80	.03	9.4	3,852	12,826	803	2,674
(D)	.70	.20	.80	.03	3.7	2,207	7,351	461	1,535
(E)	.75	.20	.80	.03	4.9	2,477	8,249	517	1,720
(F)	.95	.10	.90	.02	18.6	9,047	30,126	1,875	6,244
Two-year calving									
(A)	.90	.20	.80	.03	10.6	4,241	14,123	902	3,005
(B)	.95	.10	.90	.02	23.3	12,874	42,871	2,735	9,109

S = proportion of weaner heifers suitable for breeding.

R = annual replacement rate of beef breeding herd (deaths and cull losses).

C = average calving rate (survival to weaning as proportion of cows bred).

D = average annual death rate for heifers.

BIBLIOGRAPHY

1. Acland, J.O.
   1966. "The Management and Profitability of Beef Cattle on a South Canterbury Foothill Property," Sheepfarming Annual.

2. Agra Europe
   1970-73. Weekly. Various issues.

3. All-Grain Feeding of Livestock
   1971. New Zealand Jour. of Agr. Feb.

4. The Alternatives to Schédule
   1970. 48th Annual Report New Zealand Meat Producers Board.

5. Baker, G. E.
   1967. "Tanker Collection of Milk," Dairyfarming Annual.

6. Banfield, G. L.
   1963. "Technically Reasonable Potentials of the South Ackland Land District," New Zealand Inst. of Agr. Sci. Proc.

7. Barton, R.A.
   1958. "Possible Diversification of New Zealand Primary Production: Sheepfarming," New Zealand Inst. of Agr. Sci. Proc.

8. _____
   1965. "Quality in Cattle and Beef--A Changed Concept," Sheepfarming Annual.

9. _____
   1965. "The New Zealand Bobby Calf Industry-Past, Present and Probable," New Zealand Agr. Sci. Proc. Sept.

10. _____
    1966. "Dairy Beef and Veal: The Main Findings of the Working Party of the Agricultural Production Council," Sheepfarming Annual.

11. _____
    1966. "The Economic Importance of Dairy Beef," Sheepfarming Annual.

12. _____
    1968. "A Comparison Between Beef-bred and Dairy-bred Steers for Growth and Carcass Characteristics--Trial IV," Sheepfarming Annual.

13. _____
    1970. "Consumer Preference and the Classification and Grading of Beef Carcass," in (28).

14. _____
    1970. "Dairy Beef Production: Prospects are Bright," New Zealand Jour. of Agr. July.

15. Batten, G. J., and R. J. McDonnell
    1966. "New Stock Feeding Procedures," New Zealand Agr. Sci. Sept.

16. Bergstrom, A. R.
    1955. "An Econometric Study of Supply and Demand for New Zealand's Exports," Econometrica, Vol. 23, No. 3 July.

17. Bewley, J. K.
1970. "A Survey of Changes in Production, Manufacturing, and Marketing in the New Zealand Dairy Industry, 1947-48 to 1967-68," New Zealand Geographer, Vol. 26, No. 1. Apr.

18. Blackmore, L. W.
1964. "Chemical Renovation of Pasture," Dairyfarming Annual.

19. Blomfield, P. D.
1968. "Export Marketing of Agricultural Products," New Zealand Agr. Sci. Sept.

20. Brougham, R. W.
1966. "Pasture Management for High Production," Dairy Farming Annual.

21. _____
1966. "Potential of Present Type Pastures for Livestock Feeding," New Zealand Agr. Sci. Sept.

22. _____
1969. "Pasture Production and Management," Dairyfarming Annual.

23. Bryant, A. M.
1969. Increasing Feed Supplies for High Stocking Rates. Reprint from Ruakura Farmers Conf. Proc.

24. Burgess, A. C.
1963. "An Assessment of the Potential Carrying Capacity of the Hawke's Bay and Gisborne Land Districts," New Zealand Inst. of Agr. Sci. Proc.

25. Cairnes, I. J.
1972. "The Importance of Diversion of Dairy Cattle to the National Beef Herd." Unpublished. March 7.

26. Cameron, M. L.
1967. "An Introduction to North Auckland Farming," New Zealand Grassland Assoc. Proc.

27. Campbell, A. G.
1968. Agricultural Science in the Human Environment. Reprint from New Zealand Soc. of Animal Prod. Proc., Vol. 28.

28. _____ (ed.)
1970. New Zealand Beef Production, Processing, and Marketing. New Zealand Inst. of Agric. Science (Inc.). Wellington.

29. _____
1972. Aspects of Agricultural Ecology. Unpublished chap. for inclusion in Williams, G. R., ed., The Natural History of New Zealand. In press.

30. Campbell, A. G., and D. G. Clayton
1966. Increasing Stocking Rate and Butterfat Production by Redistribution of Available Feed Supply. Reprint from Ruakura Farmers' Conf. Proc.

31. _____
1970. "Combining Beef Raising with Dairying-Management and Economic Considerations," Ruakura Farmers' Conf. Proc.

32. Candler, W. V.
1965. "A New Look at Sheepfarming Agreements," Dairyfarming Annual.

33. Candy, R. A.
1964. "Can we Increase with Confidence," Dairyfarming Annual.

34. Carter, D. J.
1971. "New Zealand Agriculture," OECD Agr. Rev., Vol. 18, No. 3.

35. Cartwright, R. W.
1971. Projections of Requirements for New Dairy Export Outlets, 1970/71-1977/78. Massey Univ. (N.Z.), Market Research Centre. Commodity Rpt. No. 1. Aug.

36. Castle, L. V.
1968. "New Zealand's Trade Prospects for the 1970's," Dairyfarming Annual.

37. Castle, L. V., and J. McDougall
1969. Japan as a Market for New Zealand Exports of Meat and Dairy Products. New Zealand Inst. of Econ. Res., Paper No. 14.

38. Castle, M. E., A. G. Campbell, and D. G. Clayton
1967. Rearing Jersey Calves on Concentrates. Reprint from Ruakura Farmers' Conf. Proc.

39. Chamberlain, A. De O.
1963. "Potential Stock-Carrying Capacity of Nelson and Marlborough and the West Coast of Inangahue," New Zealand Inst. of Agr. Sci. Proc.

40. Chetwin, J. M.
1967. "The Economics of Dairy Beef and the Substitution Question." Unpublished Paper for the Agriculture Production Council Beef Committee.

41. Clark, I. N., et. al.
1970. "Local Marketing Arrangements for Store and Slaughter Cattle," in (28).

42. Clifford, H. J.
1966. "Trends in Herd Size and Milking Shed Design," Dairyfarming Annual.

43. _____
1969. "Surveys of Farm Milking Shed Performance," New Zealand Soc. of Animal Prod. Proc., Vol. 29.

44. _____
1971. "Artificial Breeding: Big Potential With Beef Cattle," New Zealand Jour. of Agr. Aug.

45. Coop, I. E.
1965. "A Review of the Ewe Equivalent System," New Zealand Agr. Sci. No.

46. Corkill, L.
1969. "Grassland Research," New Zealand Agr. Sci. Sept.

47. Court, R. H.
1967. "Supply Response of New Zealand Sheep Farmers," The Economic Record, Vol. 43, No. 102, June.

48. Cumberland, K. B., and J. S. Whitelaw
1970. New Zealand. The World's Landscapes Series. Aldine, Chicago.

49. Dingwall, A. R.
1963. "Potential Stock-Carrying Capacity of Canterbury," New Zealand Inst. of Agr. Sci. Proc.

50. _____
1963. "The Potential Stock-Carrying Capacity of Westland," New Zealand Inst. of Agr. Sci. Proc.

51. Dobson, D. J.
1971. "Trends in the New Zealand Dairy Industry." New Zealand Dairy Board. (Mimeo) Aug. 20.

52. During, C.
1967. Fertilizers and Soils in New Zealand Farming. Wellington.

53. Edmond, D.B.
1967. "Pasture Utilization and the Near Future," New Zealand Grassland Assoc. Proc.

54. Edwards, D. R.
1970. An Econometric Study of the North American Lamb Market. Lincoln College (N.Z.) AERU Tech. Paper 10. Apr.

55. Edwards, D. R., and B. P. Philpott
1969. Supply and Demand Projections of the United Kingdom Meat Market in 1975. Lindoln College (N.Z.), AERU Res. Rpt. 57.

56. Eede, J. R.
1968. "The Economics of Town Milk Supply Compared with Factory Supply," Dairyfarming Annual.

57. Estimates of Potential Farm Production of New Zealand
1963. New Zealand Inst. of Agr. Sci. Proc.

58. Evans, B. L.
1969. A History of Agricultural Production and Marketing in New Zealand. Palmerston North.

59. Everitt, G. C.
1966. "Development of the New Zealand Beef Industry," New Zealand Agr. Sci. Nov.

60. _____
1969. "Implications of Future Markets on New Zealand Lowland Farms," New Zealand Agr. Sci. Jan.

61. Everitt, G. C., and S. T. Evans
1970. "Beef Production from the Dairy Herd: An Analysis of Mortalities," New Zealand Vet. Jour., Vol. 18.

62. Falconer, W. J.
1970. "Barriers to Beef Trade," in (28).

63. Flay, A. H.
1962. "Effect on Farm Management," New Zealand Inst. of Agr. Sci. Proc.

64. Food and Agriculture Organization of the United Nations
1969-1973. Bul. Agr. Econ. and Statis. Various issues. Monthly.

65. _____
1971. Agricultural Commodity Projections, 1970-1980. Vols. I-II CCP 71/20. Rome.

66. _____
1971. Analysis of Supply Response to Price Changes. CCP 72/WP.7. Nov. 3.

67. _____
1971. Implication of the Possible Enlargement of the EEC for Agricultural Commodity Projections, 1970-1980. CCP 72/WP6. Dec.

68. _____
1971. Meat Production and Demand Projections to 1980--Methodology Notes and Comments. CCP:ME 72/4. Dec. 13.

69. _____
1971. Milk and Milk Products: Review of National Policies 1970/71. CCP 71/8. Aug.

70. For and Against Zero Grazing
1965. New Zealand Agr. Sci. Nov.

71. Frampton, A. R.
1965. A Market Target for the New Zealand Dairy Industry. Lincoln College (N.Z.), AERU No. 16. June.

72. Fraser, J. D.
1965. "Taxation Incentives," Sheepfarming Annual.

73. Frazer, A. E.
1971. "Marketing of Livestock for Slaughter in New New Zealand." Speech delivered at Coonabababran, Australia. June 21.

74. Gibbs, H. S.
1963. "Soils of New Zealand and their Limitations for Pastoral Use," New Zealand Inst. of Agr. Sci. Proc.

75. _____
1964. "Stability of Hill Country Under Heavy Stocking," New Zealand Inst. of Agr. Sci. Proc.

76. Glue, D. I.
1968. "Grazing Systems on Dairy and Sheep Farms," New Zealand Grassland Assoc. Proc.

77. Gow, N. G.
1970. "Economics of Scale and the Size of Arable Farm Units," New Zealand Agr. Sci. May.

78. Grazing and Export Meat Co. Ltd. (GEMCO)
n.d. Beef Investment Groups. (Brochure).

79. Grieg, A. W.
1969. "Pasture Production and Management in Practice," Dairyfarming Annual.

80. Hadfield, W. V.
1963. "The Agricultural Potential of Southland," New Zealand Inst. of Agr. Sci. Proc.

81. _____
1970. "The Potential for Cash Cropping in New Zealand," New Zealand Jour. of Agr. Jan.

82. Halvorson, H. W.
1958. "The Response of Milk Production to Price," Jour. of Farm Econ. Dec.

83. Hamilton, W. M.
1970. "The Future of Animal Production in New Zealand," New Zealand Vet. Jour., Vol. 18.

84. Hannah, A. C.
1970. Consumer Demand for Beef in the EEC. Lincoln College (N.Z.), AERU Tech. Paper 11. Nov.

85. Harper, R. G.
1972. "How EC will Implement Mansholt Plan for Structural Reform in Agriculture," Foreign Agr. U.S. Dept. Agr. Sept. 18.

86. Hight, G. K.
1968. "Hill Country Beef Cattle Research at Whatawhata," New Zealand Soc. of Animal Prod. Proc., Vol. 28.

87. _____
1969. Friesians on Hill Country. Reprint from Ruakura Farmers' Conf. Proc.

88. Hight, G. K., and D. C. Dalton, and D. R. Lang
1970. "Large Scale Integrated Sheep and Beef Cattle Breeding Schemes," Ruakura Farmers' Conf. Proc.

89. Holden, J. S.
1965. "The Economics of Hill Country Development," New Zealand Grassland Assoc. Proc.

90. Hollard, M. G.
1963. "Important Aspects of Town Milk Production," Dairyfarming Annual.

91. Hughes, A. H.
1969. "Agricultural Extension for the Seventies," Sheepfarming Annual.

92. Hughes, J. G., and J. O. Acland
1970. "Management Systems for Beef Breeding Cows," in (28).

93. Hughes, J. G., D. McClatchy, and J. A. Hayword
1971. Beef Cattle on Tussock Country. Lincoln Papers in Resource Management, No. 1. Lincoln College (N.Z.), Tussock Grasslands and Mountain Lands Institute. Canterbury.

94. Hutton, J. B.
1963. "The Efficiency of Utilization and Conversion of Pasture Herbage by Dairy Cattle, Beef Cattle and Sheep," New Zealand Inst. of Agr. Sci. Proc.

95. Hutton, J. B.
1967. "Agricultural Development and Research in New Zealand," New Zealand Soc. of Animal Prod. Proc., Vol. 27.

96. _____
1967. Meal Feeding. Reprint from Dairyfarming Annual.

97. _____
1968. Farming Two Cows Per Acre: At Ruakura. Three Seasons' Intensive Dairy Production. Reprint from Ruakura Farmers' Conf. Proc.

98. _____
1971. "The Next Step in Feeding More Dairy Cows," Ruakura Farmers' Conf. Proc.

99. _____
1972. Milk Protein Production: An Analysis of New Zealand's Present and Potential Capabilities. Paper for Presentation to Society for Animal Production (N.Z.).

100. Hutton, J. B., and O. F. Parker
1967. Meal Feeding for Milk Production. Reprint from Ruakura Farmers' Conf. Proc.

101. International Bank for Reconstruction and Development
1968. The World Bank Report on the New Zealand Economy. Wellington.

102. _____
1971. Recent Developments and Prospects of the New Zealand Economy. Vols. I-II. Rpt. No. EAP-20A Feb. 10.

103. International Monetary Fund
1965-72. International Financial Statistics. Various Annual Issues.

104. _____
1971. New Zealand-Recent Economic Developments. SM/71/26. Feb. 3.

105. Ioanes, R.
1972. "Demand, Production and Prices Strengthen Position of World Beef and Cattle Industry," Foreign Agr. U.S. Dept. Agr. March 6.

106. Jackson, R. G.
1968. "The Profitability of High-Producing Dairy Farms," Dairyfarming Annual.

107. _____
1971. A Study of the Economies of Size in New Zealand Dairy Farming. Summary of unpublished M. Agr. Sci. Thesis, Massey Univ. (N.Z.).

108. James, J. P.
1966. "Animal Breeding-The National Approach," New Zealand Vet. Jour., Vol. 14, No. 8. Aug.

109. Joblin, A. D. H.
1968. "Winter Feeding Trials with Beef Cattle," New Zealand Soc. of Animal Prod., Vol. 28.

110. _____
1969. "Intensive Beef Production," New Zealand Jour. Agr. July.

111. Joblin, A. D. H.
1969. Wintering Beef Cattle Weaners. Reprint from Ruakura Farmers' Conf. Proc.

112. Joblin, A. D. H., T. F. Reardon, and D. E. Phipps
1970. Concentrates for Cattle. Reprint from Ruakura Farmers' Conf. Proc.

113. Johnson, R. W. M.
1969. Fertilizer Use in Southland. Lincoln College (N.Z.) AERU Res. Report 54. May.

114. _____
1970. A Regional Analysis of Future Sheep Production in New Zealand. Lincoln College (N.Z.) AERU Res. Rpt. No. 63. July.

115. _____
1970. "The Future Profitability of Beef Production in New Zealand. Lincoln, College (N.Z.) AERU Disc. Paper 14.

116. Johnson, R. W. M., and D. McClatchy
1970. "A Regional Projection Model of the New Zealand Sheep Industry," New Zealand Economic Papers, Vol. 4, No. 1.

117. Jones, H. T.
1967. "Marketing of Increased Dairy Production," Dairyfarming Annual.

118. Keen, W. L.
1962. "The Cost-Price Squeeze in the Pastoral Industry," New Zealand Inst. of Agr. Sci. Proc.

119. _____
1964. "Planning for Development in the Sheep Industry," Sheepfarming Annual.

120. Keen, W. L., and N. G. Gow
1963. Financial Analysis of New Zealand Sheep Farms. New Zealand Meat and Wool Boards' Econ. Serv. Bul. No. 12. Wellington. Dec.

121. Kingma, O. T.
1968. The Economics and Management of Beef Cattle on the Canterbury Plains. Unpublished manuscript based on author's unpublished M. Agr. Sci. Thesis, Lincoln Col. (N.Z.).

122. _____
1969. "The Economics of Beef Production on the Canterbury Plains," New Zealand Agr. Sci. July.

123. Langer, R. H. M.
1966. "Lucerne Development for the South Island," New Zealand Agr. Sci. Sept.

124. Lattimore, R. G.
1970. "Dairy Beef Production-Pros and Cons from the Dairy Farmers' Point of View," Dairyfarming Annual.

125. _____
1970. The Comparative Profitability of Milk and Beef Production on Seasonal Supply Dairy Farms. Unpublished M. Agr. Sci. Thesis, Massey Univ. (N.Z.)

126. Law, N. H.
1969. "Research in the Meat Industry," New Zealand Vet. Jour., Vol. 17, No. 8. Aug.

127. Leonard, W. R.
1967. "Recent Advances in the Chemical Manipulation and Renovation of Pastures," New Zealand Agr. Sci. July.

128. Lewis, T. D., and E. J. Stonyer
1970. "Economic Analysis of Basic Beef Production Policies," in (28).

129. Lewthwaite, G. R.
1971. "Commonwealth and Common Market: The Dilemma of the New Zealand Dairy Industry," The Geographical Rev., Vol. 61, No. 1. Jan.

130. Long, Mary E.
1963. New Zealand's Agricultural Production, Marketing, and Trade Policies and their Bearing on U.S. Farm Exports. U.S. Dept. of Agr., Econ. Res. Serv. Foreign Agr. Econ. Rpt. 9.

131. _____
1971. "Britain's Entry into the EC Threatens the Position of New Zealand's Farm Exports," Foreign Agr. U.S. Dept. Agr. Oct. 11.

132. Lorimer, R. T.
1967. "Future Development of Sea Transport," New Zealand Agr. Sci. Nov.

133. Lowe, K. I.
1970. "Dairy Beef Production: Some Aspects of Post-weaning System," Dairy-farming Annual.

134. _____
1971. The Profitability of Beef Production on Some New Zealand Sheep Farms. Unpublished M. Agr. Sci. Thesis, Massey Univ. (N.Z.)

135. Lunn, W. L., and M. L. Smethan
1955. "The Future Farming Potential of Central Otago," Proceedings of the New Zealand Grassland Assoc. Proc.

136. Lynch, P. B.
1964. "Fertilizer Needs in Relation to Stocking Rates," New Zealand Inst. of Agr. Sci. Proc.

137. MacGillivray, P. A.
1967. "Management Outlook and Adjustment Towards Greater Farm Profits," Sheepfarming Annual.

138. Maki, W. R.
1962. "Decomposition of the Beef and Pork Cycles," Jour. of Farm Econ., Vol. 44, No. 3. Aug.

139. Managh, N.
1969. "Feedlot Wintering of Weaner Cattle," Sheepfarming Annual.

140. Mars, G. T.
1971. "A Study of Recent Trends in High Country Farming," New Zealand Meat and Wool Boards' Econ. Serv. (Mimeo). Wellington.

141. Maunder, W. J.
1963. "The Climates of the Pastoral Production Areas of the World," New Zealand Inst. of Agr. Sci. Proc.

142. McArthur, A. T. G.
1958. "Possible Diversification of New Zealand Primary Production: Dairy-farming," New Zealand Inst. of Agr. Sci. Proc.

143. McArthur, A. T. G., and K. T. Sanderson
1967. "An Assessment of the Value of Pastoral Development in Northland," New Zealand Grassland Assoc Proc.

144. McClatchy, D.
1969. Current Trends in New Zealand Beef Production and Disposal. Lincoln College (N.Z.), AERU Res. Rpt. 60. Oct.

145. _____
1969. Tower Silo Farming in New Zealand. (Parts I and II) Lincoln College (N.Z.) AERU Res. Rpt. 56 and 58.

146. McGillivray, W. A.
1968. "Changing Trends in Dairy Processing," New Zealand Agr. Sci. Nov.

147. _____
1968. "The Payment for Milk," reprint from New Zealand Jour. of Dairy Tech., Vol. 3. Sept.

148. McGrath, J. L.
1969. "The Next 15 Years in New Zealand Agriculture," New Zealand Agr. Sci. May.

149. McIvor, A. R.
1970. "Economic Research on Beef Cattle Production," in (28).

150. McKenzie, S. A.
1970. "How to make the Best Use of Nitrogen," Dairyfarming Annual.

151. McMeekan, C. P.
1961. "The Pros and Cons of High Stocking Rate," Dairyfarming Annual.

152. _____
1969. "Some World Trends in Beef Production and Marketing," 11th Meat Industry Conf. (MIRINZ) Proc. Hamilton.

153. McNab, J. D.
1970. "Health and Hygiene Requirements for Beef Meat Intended for Export and Local Consumption," in (28).

154. McPherson, G. K.
1963. "Estimates of Potential Farm Production of Otago," New Zealand Inst. of Agr. Sci. Proc.

155. Meister, A. D.
1971. Regional Linear Programming Models for the New Zealand Dairy Industry. Unpublished M. Agr. Sci. Thesis, Univ. Canterbury (N.Z.)

156. Mitchell, K. J.
1966. "Alternative Forage Crops for Livestock Feeding," New Zealand Agr. Sci. Sept.

157. Mitchell, K. J. and R. J. Lancaster
1970. "Management Systems for Growing Beef Cattle." in (28).

158. Monteath, M. A.
1966. "Vacuum Silage-An Aid to More Efficient Meat and Wool Production in West Otago and Southland," New Zealand Grassland Assoc. Proc.

159. Morgan, J. H. L., and G. C. Everitt
1968. "Beef Production from Jersey Steers Grazed in Three Environments," New Zealand Soc. of Animal Prod. Proc., Vol. 28.

160. Morgan, Q. Martin
1970. New Zealand's Livestock and Meat Industry. U.S. Dept. Agr. Foreign Agr. Serv., FAS-M-184 Rev. Oct.

161. Moriarty, M. J. (ed.)
1963. New Zealand Farm Production and Marketing. New Zealand Inst. of Pub. Admin. Wellington.

162. _____
1967. "British Entry to the EEC-The New Zealand Position," New Zealand Agr. Sci. Sept.

163. _____
1969. "New Zealand's International Trade Relations and the Future of the Meat Industry," 11th Meat Industry Conf. (MIRINZ) Proc. Hamilton.

164. Morris, J. L., H. J. Plunkett, and R. W. M. Johnson
1968. Livestock Targets in North Canterbury Hill Country: The Impact of Changing Prices. Lincoln College (N.Z.), AERU Res. Rpt. 51. Oct.

165. Morrison, I. G., and R. H. Bevin
1968. Export by Air. Report for the New Zealand Meat Producers Board. Dec.

166. Muldoon, R. D.
1969. "The Dairy Industry in New Zealand's Future," Dairyfarming Annual.

167. (New Zealand) National Development Conference
1969. Report to Second Plenary Session by the Overseas Markets and Exporting Committee. May.

168. Nerlove, M.
1958. "Distributed Lags and Estimation of Long-run Supply and Demand Elasticities: Theoretical Considerations," Jour. of Farm Econ. May.

169. Nerlove, M., and W. Addison
1958. "Statistical Estimation of Long-run Elasticities of Supply and Demand," Jour. of Farm Econ. Nov.

170. (New Zealand) Agricultural Production Council
1969. "Aid to Dairy Farms," The Bulletin, No. 11. Oct.

171. _____
1969. "Fertilizer Transport Subsidy," The Bulletin. No. 11. Oct.

172. _____
1970-71. Economic Position of the Farming Industry. Wellington.

173. New Zealand Agricultural Science
1967. "Livestock Targets Criticized." (Report of Remarks by J. B. Hutton at the Centennial Program of the Royal Society of New Zealand). Nov.

174. New Zealand Dairy Board
1961-72. Annual Report. Wellington. Various Issues.

175. _____
1968-70. Farm Production Report.

176. _____
1970. The New Zealand Dairy Industry--A Survey. Wellington. Dec.

177. _____
1971. A Survey of the Economic Structure of Factory Supply Dairy Farms in New Zealand in 1968-69. Vol. VI. Aug.

178. New Zealand Department of Agriculture
1963. Primary Production in New Zealand. Wellington.

179. _____
1966. Report (of) The Agricultural Development Conference 1963-64. Wellington. Feb.

180. _____
1970. Statistical Review of Fertilizers in New Zealand 1969-70.

181. _____
1971. Annual Report for 1970-71 for Ruakura Animal Research Station and Manutuke Research Station.

182. _____
1971. Report of the Department of Agriculture for the Year Ended 31 March 1971. Wellington.

183. _____
1971. Stock Retention Incentive Scheme. Circular 70071. Dec. 22.

184. _____
n.d. Annual Report of Research Division, 1969-70. Hamilton.

185. New Zealand Department of Inland Revenue
1969. Farmer's Tax Guide. (Pam.) Nov.

186. New Zealand Department of Lands and Survey
1971. Annual Report for the Year Ended 31 March 1971.

187. New Zealand Department of Statistics
1960-73. Official yearbook. Wellington. Various issues.

188. _____
1963-70. Farm Production. Wellington. Various Annual Issues.

189. _____
1965-73. Monthly Abstract of Statistics. Wellington. Various Issues.

190. _____
1971. External Trade 1968-69, Report and Analysis. Wellington. Feb.

191. New Zealand Department of Statistics
1972. Agricultural Statistics, 1969-70. Wellington. In Press.

192. New Zealand Government
1971. New Zealand and the European Economic Community. Wellington.

193. New Zealand Institute of Economic Research
1967-73. Quarterly Predictions. Wellington.

194. New Zealand Meat Producers Board
1962-73. Annual Report and Statement of Accounts. Wellington. Various Issues.

195. _____
1967. New Zealand Meat Markets 1966.

196. _____
1970-71. "New Zealand Dairy Herd Contribution to Export Beef and Veal Production." Unpublished Estimates, June 23, 1970 and July 16, 1971.

197. _____
1971. "Britain and the EEC: Impact on New Zealand's Meat Trade," Forty-eighth Annual Report and Statement of Accounts.

198. _____
1971. Grades Forum. (Conf. Proc.) Oct.

199. _____
1971. The Role of the Producer in the Export Meat Industry. (Brochure).

200. New Zealand Meat and Wool Boards' Economic Service
1965-71. Annual Review of the Sheep Industry. Wellington. Various Issues.

201. _____
1971. Sheep Farm Survey 1969-70. Nov.

202. _____
1971. State Advances Corp. of New Zealand Loans for Farming. (Mimeo.) Aug. 28.

203. New Zealand Milk Board
1970. 17th Annual Report.

204. (New Zealand) Monetary and Economic Council
1970. New Zealand and an Enlarged EEC. Rpt. No. 19. Wellington, June.

205. _____
1971-72. Annual Economic Trends and Policies. Wellington.

206. (New Zealand) National Development Conference
1969. Report of the Targets Committee. N.D.C. 2. Wellington. May.

207. _____
1969. Report of the Agriculture Committee. N.D.C. 3. Wellington. May.

208. _____
1969. Report to Second Plenary Session by the Overseas Markets and Exporting Committee. May.

209. (New Zealand) National Development Council
1971. Annual Report. Wellington.

210. Newell, P. B.
1970. "Economic Concept of Large Scale Farming," New Zealand Agr. Sci. May.

211. Nicol, A. M., and I. E. Coop
1970. "Nutrition of Growing Beef Cattle," in (28).

212. Norman, P. T.
1966. "The Marketing of Beef," Sheepfarming Annual.

213. _____
1967. "Meat--Potential Products and Procedures," New Zealand Agr. Sci. Jan.

214. _____
1969. "The New Zealand Meat Industry," New Zealand Vet. Jour., Vol. 17, No. 6 June.

215. Organization for Economic Cooperation and Development
1968. Agricultural Projections for 1975 and 1985. Paris.

216. _____
1968. New Zealand. (Country supplement to 215 above). Paris.

217. Parker, B.
1970. "Beef Management," New Zealand Jour. Agr. May.

218. Parker, B. W.
1970. "Dairy Beef Production: Economic Factors," New Zealand Jour. of Agr. July.

219. Parker, J. S.
1970. "The Economics of Size in Dairy Farming," New Zealand Agr. Sci. May.

220. Patrick, C.
1962. "Exporting Dairy Products," New Zealand Inst. Agr. Sci. Proc.

221. _____
1970. "Prospects for Dairy Products in the Far East," Dairy Industries. London. Sept.

222. _____
1970. "The Organization of the New Zealand Dairy Industry," New Zealand Jour. of Dairy Sci. and Tech., Vol. 5, No. 3.

223. Phillips, D. S. M.
1971. Round Sheds and Automation. Reprint from Ruakura Farmers Conf. Proc.

224. Philpott, B. P.
1963. "The Determinants of Agricultural Production in New Zealand," in (161).

225. _____
1970. Demand Prospects for Beef. Lincoln College (N.Z.) AERU Disc. Paper 15.

226. Philpott, B. P., I. D. Grieg, and A. Wright
1972. Some Aspects of the Economics of Nitrogen Storage Farming in New Zealand. Lincoln College (N.Z.) AERU Disc. Paper. Unpublished.

227. Pilling, R. G.
1969. Recent Developments in the Meat Industry with Particular Reference to Otago and Southland. Lincoln College (N.Z.) AERU Disc. Paper 13. Nov.

228. Pitcher, S.
1971. "Australia-New Zealand Meat Exports, Production Establish Second Record," Foreign Agr., U.S. Dept. Agr. Dec. 27.

229. Plunkett, H. J.
n.d. Land Development by Government 1945-69. (Chaps. II, V, and VI). Lincoln College (N.Z.), AERU Tech. Paper 14.

230. Quinn, J.
1969. "Grass Growing with Nitrogen," New Zealand Jour. of Agr. Nov.

231. Rae, A. L.
1969. "Implications of Future Market Demands on Hill Country Farms," New Zealand Agr. Sci., Jan.

232. _____
1970. "The Future of Agricultural Research in New Zealand: Animal Genetics and Breeding Possibilities," New Zealand Agr. Sci. Jan.

233. Rattray, P. V., and J. P. Joyce
1969. "Higher Beef and Sheepmeat Returns Possible," New Zealand Jour. of Agr. July.

234. Reserve Bank of New Zealand
1969-72. Bulletin. Wellington. Various Monthly Issues.

235. Reynolds, N. F.
1970. "How to Win at Dairying," Dairyfarming Annual.

236. Ridler, D.
1962. Far East Markets for New Zealand's Meat and Milk. New Zealand Inst. of Econ. Res., Rpt. No. 3.

237. Roberts, I. M., and G. L. Miller
1971. "An Analysis of the EEC Market for Beef and Veal," Quarterly Rev. of Agr. Econ., Vol. 25, No. Canberra. July 3.

238. Saunders, W. J. H.
1967. "Soils and Animal Production," Sheepfarming Annual.

239. Schroder, W. R.
1970. Introduction, Review and Conclusions to Part 5. Marketing and Processing, in (28).

240. Scott, J. D. J., J. P. Joyce, and M. A. Monteath
1970. "Integration of Beef Cattle into Farming Systems," in (28).

241. Scott, J. M.
1969. "The Economic Aspects of Fertilizer Use," Dairyfarming Annual.

242. Shaffer, R. H.
1967. The Balance of Payments of a Small Dependent and High Income Country: The New Zealand Case. Unpublished Ph.D. thesis, Duke Univ.

243. South Auckland Beef Development Committee
1971. Beef Developments, Vol. 5, No. 2. Oct.

244. Stanley, F. G.
1969. "A Forward Look at the Meat Industry," 11th Meat Industry Conf. (MIRINZ) Proc. Hamilton.

245. Stewart, J. D.
1968. "Profitability and Economics of Cropping," New Zealand Grassland Assoc. Proc.

246. _____
1970. "New Zealand Agriculture in the 1960's and 1970's. Policies and Trends," Farm Policy, Vol. 9, No. 4. Mar. Nedlands, W. Australia.

247. Stichbury, J. N.
1966. "Potential Development in Dairy Cattle and Dairying," New Zealand Agr. Sci. Nov.

248. _____
1970. "Dairy Farming in New Zealand," Jour. of Dairy Sci. and Tech., Vol. 5, No. 3.

249. _____
1971. "Dairying is More Profitable Than Beef," New Zealand Dairy Exports. Feb.

250. Strauss, E.
1971. "Nature and Scope of Possible International Arrangements for Orderly Marketing of Dairy Products," Dairy Industries. London. Jan.

251. Stuart, A.
1963. "Estimates of Potential Farm Production for the Wellington and Taranaki Land Districts," New Zealand Inst. of Agr. Sci. Proc.

252. Sutch, W. B.
1967. "Implications for New Zealand of Joining the EEC," New Zealand Agr. Sci. Sept.

253. Symmans, G. W. (ed.)
1969. Report of the Proceedings of the National Development Conference Plenary Session 27-29 Aug. 1968. Wellington.

254. Tier, T. J.
1969. The Market for New Zealand Beef-a Preliminary Assessment. Massey Univ. (N.Z.) Dept. of Agr. Econ. and Farm Mgt. Disc. Paper 51. May.

255. Torswill, A. N.
1965. "The Role of Hill Country in Future Increases in Production," Sheep-farming Annual.

256. Tuck, I. D.
1968. "Breed or Beef? The Cost of Dairy Herd Replacements," Dairyfarming Annual.

257. Turnovsky, S. J.
1968. "International Trading Relationships for a Small Country: The Case of New Zealand," Canadian Jour. of Econ., Vol. 1, No. 4. Nov.

258. United States Department of Agriculture
1972-73. Foreign Agriculture Circular. Various issues.

259. _____
1973. U.S. Foreign Agricultural Trade Statistical Report, Calendar Year 1973. May.

260. Walker, S. D., and W. R. Lobb
1968. "Beef Production: Potential and Output in Mid-Canterbury," New Zealand Grassland Assoc. Proc.

261. _____
1968. Beef Production: Potential and Output in Mid-Canterbury. Reprint from New Zealand Grassland Assoc. Proc., Vol. 30.

262. Wallace, L. R.
1966. "The Importance of Animal Production to the National Economy," New Zealand Vet. Jour., Vol. 14, No. 9. Sept. Wellington.

263. Walton, T.
1970. "Beef Cattle Productivity Testing," New Zealand Jour. of Agr. July.

264. _____
1971. "Barriers to New Zealand's Trading Future," New Zealand Agr. Sept.

265. Ward, A. B.
1970. "Investment in Dairy Farming," Dairyfarming Annual.

266. Ward, A. H.
1967. "The New Zealand Industry and the EEC," New Zealand Agr. Sci. Sept.

267. Ward, F. L.
1964. "The Export Market for Beef and Beef Cattle on Sheep Farms on New Zealand," Address to Federated Farmers. Oct. 22.

268. _____
1968. "Future Requirements for Expanded Beef Production in New Zealand," New Zealand Soc. of Animal Prod. Proc., Vol. 28.

269. _____
1971. "Long Range Economics of Sheep Farming," Address to New Zealand Vet. Assoc. June 18.

270. Ward, I.
1969. "Farm Subsidies-Help or Hindrance," Dairyfarming Annual.

271. Watson, N.
1967. "Farm Diversification to Meet Changing Times," Sheepfarming Annual.

272. Watt, I. G.
1970. "Big Changes in Meat Hygiene," New Zealand Jour. of Agr. June.

273. White, J. V.
1963. "Pricing of Agricultural Products," in (161).

274. _____
1968. "The Marketing of Animal Products," New Zealand Agr. Sci. Nov.

275. Woods, N. S.
1965. "Farm Manpower," Sheepfarming Annual.

276. Woolven, A. H.
1969. "Dairy Produce-The Point of View of the Producer," Paper Presented at the Assoc. Chambers of Commerce of New Zealand, Annual Conf.

277. Yandle, C. A.
1968. An Econometric Model of the New Zealand Meat Market. Lincoln College (N.Z.), AERU Tech. Paper 7. Nov.

278. Yerex, D. K.
1972. "New Company Gem of an Idea," New Zealand Jour. of Agr. Feb.

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1/ Numbers refer to page numbers.

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ADDENDUM
to
USDA-ERS, FAER No. 97 (1974)
New Zealand: Growth Potential of the Beef and Dairy Industries

by

Robert D. Barry

A-3

July 1976

Foreign Demand and Competition Division

Economic Research Service

U.S. Department of Agriculture

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U. S. Department of Agriculture, Economic Research Service, New Zealand: Growth Potential of the Beef and Dairy Industries, by Robert D. Barry, FAER No. 97 (1974).
July 1976

The world economy has experienced a major recession, oil prices have quadrupled, and much has occurred in the world cattle economy beyond the study's historical data. The purpose of this addendum is to relate these recent events to the study's findings.

- - -

The world economy expanded vigorously in 1972 and the first half of 1973. Then a serious recession began, from which recovery is only lately taking place in 1976. Inflation has been a persistent problem through the 1970's and reached alarming dimensions after the oil price hikes of late 1973.[1] In this period, New Zealand's on-farm costs of beef and dairy production and off-farm processing and distribution costs ballooned just as world import demand and protectionist policies shrank markets for New Zealand's pastoral products:

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[1]U. S. Department of Agriculture, World Monetary Conditions in Relation to Agricultural Trade, November 1974, pp. 1-5.

	Volume of exports, in 1,000 tons			Value of exports, in million dollars		
	1972/73	1973/74	1974/75	1972/73	1973/74	1974/75
Beef and veal	200	181	188	240	236	160
Butter	169	157	162	135	107	122
Cheese	94	68	64	79	62	48
Lamb and mutton	434	345	377	257	257	237
Wool	283	211	215	424	363	262

SOURCE: New Zealand Department of Statistics, Monthly Abstract of Statistics, December 1975, pp. 33, 36-37; New Zealand Meat Producers Board Annual Report and Statement of Accounts, 1973/74, p. 32.

Beef cattle industry

Production of beef in the major exporting countries (Australia, New Zealand, Central and South America) increased 16 percent from 5.3 million long tons (MLT) (carcass weight) in 1973 to 6.14 MLT in 1975, at the same time that production in the major importing areas (United States, Canada, EC-9, and Japan) rose 18 percent from 16.2 MLT to 19.2 MLT. World beef consumption, though weakened by recession, continued to rise; however, world trade declined as demand growth in the importing countries was met by increased domestic output. Temporary gluts of beef and veal were

created world-wide and prices dropped sharply. As U.S. supplies rose in 1975, the "voluntary restraint" export program to forestall imposition of meat import quotas was re-instituted (see Chapter VIII). In Japan, all imports of beef were suspended between February 1974 and June 1975. The EC-9 banned beef and veal imports (except quota amounts under GATT) on July 1974, and EC-9 imports of beef and veal fell from 969,000 tons in 1973 to 426,000 tons in 1974 and down to 197,000 tons in 1975.[1]

In New Zealand, the beef cattle industry suffered a major reversal. The average wholesale price for New Zealand cow beef in the United States (the major market) slipped from 62.6 cents a pound in 1973/74 to 41.8 cents in 1974/75, and the New Zealand schedule price to the producer, for manufacturing grade beef, dropped from 28.3 cents a pound in 1972/73 to 11.3 cents in 1974/75. A minimum schedule price of 18.1 cents a pound in 1975/76 was established by the Meat

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[1]U.S. Department of Agriculture, Foreign Agriculture Circular: Livestock and Meat, April 1976; U.S. Department of Agriculture News Releases 916-74, 2816-74, and 3315-75; (USDA) Agricultural Situation in Western Europe, April 1975 and April 1976; K. Suzanne Early, "World Meat Surpluses Persist as Exporters' Output Soars," in (USDA) Foreign Agriculture, 10 November 1975, pp. 2-3, 12.

Board to shore up the industry.[1] Concurrent with the product price decline, the index (1960=100) of estimated charges on New Zealand boneless cow beef from farmgate to c.i.f. New York rapidly climbed from 200 in 1972/73 to 354 in 1974/75. The index of prices paid for inputs by sheep farmers (most beef cattle are still raised on sheep farms) rose from 144 in 1972/73 to 186 in 1974/75; sheep farmers' terms of exchange (prices received ÷ prices paid) fell from 128 to 69 in the same 2-year period. From a peak of $18,800 in 1972/73, net income per sheep farmer slid to $5,300 in 1974/75.[2]

How well has the beef cattle production model in this study (Equation 4, Chapter VII) predicted actual numbers? Using Set I (Most Likely) numbers for comparison, the difference is negligible (less than 2 percent) between the projected 6.665 million and the actual 1975 figure of

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[1]New Zealand Meat and Wool Boards' Economic Service, Annual Review of the Sheep Industry, 1974/75, p. 18; G.N. Zanetti, et al., Report of the (New Zealand) Farm Incomes Advisory Committee to the Minister of Agriculture and Fisheries, March 1975, p. 101 (hereafter Zanetti Report).

[2]Zanetti Report, pp. 97, 107-8; Harold T. Sanden, "New Zealand Livestock Producers Face Some Difficult Decisions," in (USDA) Foreign Agriculture, 5 May 1975, pp. 5, 12; idem, "New Zealand: Cattle Herds Are Up, Earnings from Meat Exports Down," in (USDA) Foreign Agriculture, 3 March 1975, pp. 2-3, 15; U.S. Foreign Agricultural Service, Dispatch NZ-6004, 20 February 1976.

6.574 million beef cattle. For 1980, however, the model's projected 8.211 million could be on the high side because of (1) the depth to which prices have sunk since 1973, and (2) the heavy kill of heifers (75 percent greater in 1974/75 than in the prior season) which will moderate growth of the beef herd for at least two seasons.[1] A 95-percent prediction interval can be calculated for the projected beef cattle figure for 1980:[2]

$$B_{80} = \hat{B}_{80} \pm (S.E.E.)(t_{.025}) \sqrt{x_{80} \, V \, x'_{80} + 1},$$

where $V = (X'X)^{-1}$ = the inverse of the matrix of observations that determined the regression coefficients;

x_{80} = the row vector of values of the regressors, in 1980.

$\hat{B}_{80}$ = 8210.7 = number of beef cattle in 1980, as caluclated by the model, in thousands.

$$x_{80} = \begin{bmatrix} 1 & 236.7 & 7903.8 & 1980 & 1980 \end{bmatrix}$$

and

$$X = \begin{bmatrix} 1 & 60 & 2915 & 0 & 1959 \\ 1 & 68 & 2870 & 0 & 1960 \\ 1 & 90 & 3019 & 0 & 1961 \\ 1 & 100 & 3334 & 0 & 1962 \\ 1 & 90 & 3462 & 0 & 1963 \\ 1 & 62 & 3558 & 0 & 1964 \\ 1 & 85 & 3568 & 0 & 1965 \\ 1 & 100 & 3628 & 1966 & 1966 \\ 1 & 150 & 3856 & 1967 & 1967 \\ 1 & 150 & 4241 & 1968 & 1968 \\ 1 & 120 & 4549 & 1969 & 1969 \\ 1 & 125 & 4812 & 1970 & 1970 \end{bmatrix}$$

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[1] New Zealand Meat Producers Board, Annual Report, 1974/75, p. 11.

[2] Ronald J. Wonnacott and Thomas H. Wonnacott, Econometrics (New York: John Wiley & Sons, 1970), pp. 259-261.

Then $B_{80} = 8210.7 \pm (2.365)(67.29)\sqrt{16.1 + 1}$

$B_{80} = 8210.7 \pm 652.5$

$$B_{80} = \begin{cases} 8863.2 \\ 7558.2 \end{cases}$$

With a 95-percent probability, the number of beef cattle is predicted to fall within a range of 8.863 and 7.558 million. For reasons already given, the actual 1980 figure will probably be closer to the lower limit.

If the production response model (Equation 4) were re-run with the addition of more recent data, the coefficients would change as follows:

Equation 4a

B	= -21,009.31 +	2.34 PSG^{***}_{t-2} +	0.82B^{***}_{t-1} +	0.08 SPT^{**} +	10.96T
t	=	3.00	6.32	1.84	0.40
S.E.	=	0.78	0.13	0.04	27.27
b	=	0.14	0.76	0.07	0.05

$\bar{R}^2$ = 0.992 Durbin h = -0.16

E_s = 0.07 E_l = 0.39

F***(4,12) = 814.70 S.E.E. = 78.26

The results are statistically superior, with both PSG and B_{t-1} significant at the 1-percent level, SPT significant at the 5-percent level, negligible serial correlation in the residuals, higher F value, and about the same $\bar{R}^2$ as in Equation 4. The short-run and long-run elasticities of

production are somewhat lower; and using the equation to project 1980 beef cattle numbers (starting with the actual 1975 stock and the same price series as used with Equation 4, Projection Set I) would give a total 7.152 million beef cattle in 1980. This could turn out to be too low. Much will depend on access to, and market prices received in, the United States, EC-9, and Japan. In 1976, some improvement in beef industry prospects is discernible: prices have risen 20 cents a pound over 1975 on the bulk of beef going to North America;[1] Japan has raised import quotas for beef; and the EC-9 embargo on beef and veal imports has been eased.[2] "The New Zealand livestock industry, after two years of falling prices in the world market, is now facing the future with some degree of optimism. . . ."[3]

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[1]U.S. Foreign Agricultural Service, Dispatch NZ-6004, 20 February 1976.

[2]New Zealand Meat Producers Board, Annual Report, 1974/75, pp. 61-63.

[3]Ibid., p. 1; U.S. Foreign Agricultural Service, Dispatch NZ-6004, 20 February 1976. Note (USDA) Foreign Agriculture Circular: Livestock and Meat, April 1972, p. 11:

> "Part of the optimism exhibited by cattle producers may be because of the Meat Board's new price stabilization scheme for cattle and sheep meats that was approved by the Government last October (1975). The scheme encompasses guaranteed minimum prices for beef, mutton, and lamb, based on a 3-year moving average of prices--forecast average price for the current season, estimated average price for the past season, and the actual average price for the previous season."

Dairy cattle industry

World dairy, like beef, has experienced a roller-coaster ride in the recent period. The market was buoyant in 1973/74, but then deteriorated as the world recession and high dairy product prices (tied to high support programs in the EC-9 and the United States) dampened demand. Between 1972/73 and 1974/75, world butter exports fell 14 percent to 0.91 MLT, nonfat dry milk (NFDM) exports fell 21 percent to 0.87 MLT, and cheese exports only partially offset these declines by rising 14 percent to 0.95 MLT. In the EC-9, as dairy surpluses (especially NFDM) mounted, the cost of milk support programs reached an estimated U.S. $2 billion in 1975.[1]

In New Zealand, gross income per dairy farm rose from $19,600 in 1972/73 to $23,300 in 1974/75 even though the price per pound butterfat (in milk at the factory door, for cheese) slipped to 57.8 cents a pound after rising from 50.7 cents in 1972/73 to 60.3 cents in 1973/74. Expenditures more than kept pace, however, and net farm income of $7,600 in 1974/75 was about the same as in 1972/73. In terms of indices (1960 = 100), prices paid by dairy farmers for their

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[1]U.S. Department of Agriculture, Foreign Agriculture Circular: Dairy, December 1975 and March 1976 issues; Lloyd J. Fleck, "Nonfat Surplus Emerges as Latest World Dairy Problem," in (USDA) Foreign Agriculture, September 1975, pp. 2-4, 12.

production inputs rose from 150 to 200 in 1972/73 - 1974/75, and the terms of exchange (prices received ÷ prices paid) declined from 123 to 115. The index of freight charges for butter exports to the U.K. shot up from 198 to 294 in the 2-year period.[1]

Although the New Zealand dairy industry weathered the recent world economic recession rather well and apparently improved its profitability relative to beef and sheep raising, the stock of dairy cows in milk (DCM) continued to fall gradually from the 1970 peak of 2.321 million to 2.080 million in 1975. A short-term factor was unusually dry weather during 1972--74, especially the severe drought of 1973 which, together with attractively high manufacturing beef prices, induced a heavy culling of dairy cattle. The more pervasive reasons are sociological and economic: the general scarcity of farm labor; a growing disinterest in dairy farming as a way of life; movement to other farm occupations such as cropping, horticulture, and (at least through 1973) to beef raising; and the continued vulnerability and uncertainty of dairy product markets. Moreover, "recently inflated land values have checked the growth that

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[1]New Zealand Dairy Board, Annual Report, 1974/75, pp. 41-42; Zanetti Report, pp. 110-11.

might have been expected to accompany the (relatively) good returns from dairy farming."[1]

Because of the unexpected decline in DCM numbers, the projection of 2.548 million DCM in 1975 given by the dairy production model (Equation 5, Chapter VII) overestimates the actual 2.080 million DCM, by 18 percent. A 95-percent confidence interval based on the model's 1980 projection, can be computed:

$$DCM_{80} = \hat{DCM}_{80} \pm (S.E.E.)(t_{.025}) \sqrt{z_{80} Z z'_{80} + 1}$$

The terms are analogous to those given previously for beef cattle numbers. The results are:

$$DCM_{80} = 2784.6 \pm (2.306)(23.64) \sqrt{13.2 + 1}$$

$$= 2784.6 \pm 207.2$$

$$= \begin{cases} 2991.8 \\ 2577.4 \end{cases}$$

The New Zealand Dairy Board expects DCM to reach 2.4 million in 1979, and so the extrapolated 1980 DCM would be higher than 2.4 million, and not too far off the lower level of the prediction interval.[2] If the recent data showing declines in DCM were incorporated into the model, the results would be very unsatisfactory:

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[1] New Zealand Dairy Board, Annual Report, 1973/74, p. 12.

[2] U.S. Foreign Agricultural Service Dispatch NZ-4005, 4 March 1974.

Equation 5a

$$DCM = 17{,}815.79 - 1.44\ PMF_{t-2} + 0.72\ DCM^{**}_{t-1} + 9.45T$$

$$t = \quad 1.26 \quad 2.59 \quad 0.87$$

$$S.E. = \quad 1.14 \quad 0.28 \quad 10.80$$

$$\bar{R}^2 = 0.855$$

The sign on the price variable is perverse, and the coefficients are not significant except for that of the lagged DCM.

The future for New Zealand's dairy remains very largely in the hands of policy makers in the major dairy markets, particularly the EC-9. Guaranteed c.i.f. prices for New Zealand butter and cheese entering the U.K. under Protocol 18 of the Luxembourg Agreement (see Chapter VIII) were raised 18 percent beginning January 1975, after returns had been frozen at 1969-72 average price levels during 1973-74; and provisions have been made for continued U.K. imports of New Zealand butter during 1977-80, but on a declining basis to a figure of only 113,000 metric tons in 1980 from 138,176 tons in 1977.[1] The EC-9 has a number of plans to stem its high-cost milk overproduction problem, but the prospects seem hardly encouraging.[2] There

[1](New Zealand) Quarterly Predictions, March 1976, p. 12.

[2]Mattie R. Sharpless, "EC Begins Push to Reduce its Nonfat Dry Milk Surplus," in Foreign Agriculture, 26 April 1976, pp. 2-3, 12; Lloyd J. Fleck, "EC Dairy Product Surplus May Worsen During 1976," in Foreign Agriculture, 26 April 1976, pp. 3-5.

appears little guarantee that New Zealand's capacity to produce milk at the lowest prices in the world will be fully realized.